IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MASSACHUSETTS

PACIFIC INDEMNITY COMPANY, Plaintiff, v. ALFRED KEMP, Individually and d/b/a KEMP PLUMBING and MARTIN SANDBORG, Individually and d/b/a SANDBORG PLUMBING AND HEATING, Defendants.	CIVIL ACTION NO. 04-11975(RWZ) **AFFIDAVIT OF DANIEL Q. HARRINGTON IN OPPOSITION TO DEFENDANT KEMP'S MOTION IN LIMINE TO PRECLUDE TESTIMONY FROM PLAINTIFF'S EXPERT THOMAS KLEM**

Daniel Q. Harrington, being first duly sworn, states as follows:

1. I am an attorney duly admitted to practice law in Pennsylvania, New Jersey, New York and Minnesota, and in numerous federal courts, and have been admitted to appear *pro hac vice* for the plaintiff in this matter.

2. Attached as Exhibit "A" is a copy of the Massachusetts State Fire Marshal's Office Fire Investigation Summary Report for Case No. 2002-117-2011, relating to the fire at the Marino carriage house at 256 Westfield Street in Dedham, Massachusetts, which is the subject of this litigation.

3. Attached as Exhibit "B" is a copy of my July 29, 2005 letter, sent via FedEx and Fax, to defendant's counsel in this matter, advising that I might call Sergeant Francis McGinn, the author of the report attached as Exhibit "A," to testify at trial in accordance with the report.

4. Attached as Exhibit "C" are excerpts from NFPA 921 (2004 Edition) which are referenced in Plaintiff's Memorandum of Law in Opposition to Defendant Kemp's Motion in Limine to Preclude Testimony From Plaintiff's Expert Thomas Klem.

5. Attached as Exhibit "D" is a copy of the Decision in U.S. v. Black Wolf, 1999 U.S. Dist. LEXIS 20736 (D.S.D. 1999).

6. Attached as Exhibit "E" is a copy of the Decision in Torske v. Bunn-O-Matic Corp., 2004 U.S. Dist. LEXIS 14570 (D.N.D. 2004).

7. Attached as Exhibit "F" is a copy of the Decision in Erie Insurance Exchange v. Applica Consumer Products, Inc., 2005 W.L. 1165562 (M.D. Pa. 2005).

8. This Affidavit is being submitted in Opposition to Defendant Kemp's "Motion In Limine To Preclude Testimony From Plaintiff's Expert Thomas Klem."

DANIEL Q. HARRINGTON

SWORN TO AND SUBSCRIBED

BEFORE ME THIS 22nd DAY

OF March, 2007.

LORRAINE S. COSTRO
COMMONWEALTH OF PENNSYLVANIA
COMMISSIONER OF DEEDS
COMMISSION EXPIRES MAR. 3, 2008

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Fire Investigation Summary Report

Case Number: 2002-117-2011
Controlling Case Number: None
Case Type: F10 Fire - Undetermined

Report Creator: Francis M McGinn
Lead Investigator(s): Francis M McGinn Team: South

FIU Requested By: Lt John Fontaine from Dedham Fire Department
FIU Requested On:

Date and Time of Incident: 12/20/2002 at approximately 02:24 AM
Address/ Location of Incident: 256 Westfield St. Dedham, MA

Type of Investigation: Fire
Type of Property: Residential

Protection Systems:
No Known Detection System Present
Smoke Detector: Not Operational
Comments: Property was a three story brick and heavy timber constructed building with steel I beam supports and concrete floors. The building had a terra cotta clay roof and large glass entryway in the front/ A side. The building had three dormers on the A side. The building was approximately 98% complete with ongoing renovations. The building was to house a guest suite, office, workout room/ gym, pool table room, sitting room with audio system and fireplace and kitchen. The basement of the building housed an elaborate electrical system complete with a snow melt system. the basement also housed cabana type men and womens baths and changing rooms, saunas and hot tub.

Fire Source

Cause of Fire: Undetermined
Ignition: unknown
Material Ignited: available combustibles in the area of origin
Explanation:
NOTIFICATION AND RESPONSE

1. On Friday, December 20, 2002 at approximately 07:00 AM, I was notified of a fire at 256 Westfield St in the town of Dedham. As a result of that notification, I responded and met with Deputy Chief Peter Colantuoni and LT John Fontaine of the Dedham Fire Department. They informed me that the Dedham Fire Department responded to a working fire at 2:24 AM. Upon arrival they found heavy fire in the kitchen, living room with fireplace, and entry way with a spiral staircase. The fire had also extended to the second floor and breached the roof and one of the dormers. Upon my arrival in the morning, the fire department was still extinguishing hot spots in the building. LT Fontaine and I then initiated an origin and cause investigation into the circumstances of the fire. Trooper Varkas arrived a short time later and assisted in this investigation.

2. I was informed that the fire was reported by former Dedham Fire Chief Bob Cullinane who is a caretaker for the Marino's property. I spoke with Bob Cullinane. He informed me that he was called by Roger Marino and told that the carriage house was on fire. He called the fire department, went up to the building and saw the kitchen fully involved. He also said that the fire had already breached the dormer on the right side and the front door and side kitchen door had already burned away. Bob also told me that his son Brian came home around 01:00 AM and did not see anything suspicious, no lights or fire.

PLAINTIFF'S EXHIBIT
tabbies
A

Fire Investigation Summary Report

3. I also spoke with the owner, Roger Marino. Mr. Marino told me that he was up to use the bathroom and saw what he though was hail stones out of his kitchen window. As he looked out of the kitchen window from the main house, he saw fire right of the center of the roof. Roger said when he went up to the carriage house, he could see fire at the stairway but could still see the bannister. He said there was more fire in the kitchen area.

WITNESS INTERVIEWS

4. This investigation spoke with numerous contractors that were working on the building. I first spoke with Kraig Magnussen, the superintendent of the property. I asked Kraig what kind of work was being done the day prior to the fire. Kraig told me that the deck was being painted, the floors were being sanded and stained in the pool table room. There was Tile work being done in the basement bathrooms. There were two Plumbers doing finish work from Sanborg Plumbing. The two plumbers doing the work were Alfred Kemp and Phil Shields. Kraig told me that he doesn't allow smoking in the building . There were no candles burning in the building. The heating system was a LP fired boiler with radiant heating by way of plastic coated tubing inlaid into the subflooring. The building had an elaborate 400 amp electrical system. Kraig was doing some work in the kitchen in the vicinity of where the stove was to be placed. Kraig said that he secured and left the building around 4:15 PM after doing a final walk through. Kraig, later in the investigation, said that one of the last things he did was help Al Kemp clean up the kitchen area. He also put on two night lights on out in the front of the building. I asked Kraig who had keys to the building. He told me that besides himself, Bob Cullinane, Carol (the decorator), and the Marinos had the only keys. There was no sign of forced entry to the building at the doors that remained intact after the fire. The front door and side kitchen door were burned away so we were unable to determine if they had been forced open or not.

5. We verified with the paint crew and Kraig Magnussen that all of the rags were put into two buckets of water and removed from the house at the end of the day. Denis Boiteau's paint crew (Francis Desjarlais and Tim Johnson) did the staining and were using Minwax stain. Denis told this investigation that his crew's SOP is to put the stain rags in a bucket of water and to put the bucket outside. Denis also said that his crew was not using any polyurethane. Vengetic Floors did the sanding. Jose Barrientos and Jose Guerra sanded the floor in the pool table room and finished about 1:00 -1:30 PM. Jose Barrientos told this investigation that all of the sawdust was put in one bag and left outside of the front door house to the left as one faces the building.

6. We also spoke with Larry Dicken, who was doing the tiling. He said that he was working the day prior to the fire. He said that he was moving stock from one part of the basement to another and he started laying tile in the basement on the left side towards the pool. He was using a double duty adhesive called Mapai. Larry began at noon and left at 4:00 PM.

7. We also spoke with Alfred Kemp who was doing the plumbing work. Al told us that it was a finish day. He installed closet flanges and toilets on the second floor in the morning. At around midday he went to the main house with his helper, Phil Shields, and pulled a toilet and replaced it, then brought the old one to the carriage house. Al told us that he worked on the kitchen sink and installed the dishwasher in the afternoon. Al said that he started in the kitchen around 1:30 PM. He popped a hole in the kitchen sink for a hot water hook-up. He put the dishwasher in and pulled 1/2 inch tubing but did not make the connection. Al further told us that Phil left at about 2:00 PM. Al said that he did have a torch in the building but did not use it. He said there was no soldering done. Al said he stopped working about 3:30 PM and left about 4:00 PM. Al mentioned that he had to sweat the Lav risers the day before.

8. Phil Shields told this investigation the following: He arrived on the job site at 8:15 AM. He began the day attaching faucets to sinks on the second floor baths. At 9:00 AM, Phil went to get stock and coffees and returned at 10:00 AM. He went up to the second floor to set a tub with Al. Phil then went over to the other bath and trapped the other sink. Phil said that Al went downstairs around noon while Phil cleaned up. Phil said that he and Al then set a pedestal sink on the first floor in the powder room. At 1:00 PM Phil and Al went to the main house, pulled a toilet, replaced it with another and then brought the toilet to the carriage house and set it on the second floor bath. Phil said that he and Al then went to the kitchen and worked on

Fire Investigation Summary Report

the sink. Phil said they cut a hole in the kitchen sink using Greenlee cutters. Phil said that at about 3:00 PM he left to meet Marty at another site. I asked Phil if he or Al were doing any soldering on Wednesday. Phil told me that he was not soldering and he didn't think Al was doing any soldering either. Phil said that he did not put any stops in on the first floor, he did the second floor and basement. Phil said that Al did all the stops on the first floor. Phil said that he did not put a stop in at the dishwasher.

9. On December 31, 2002, I met with Al Kemp in Braintree for another interview. During this interview, I asked Al about a drop cloth that we found at the scene. Al told me that Kraig rolled up the drop cloth at the end of the day. Al said that he does not use a cloth drop cloth when he solders. He said he will usually use cardboard or wood while soldering. When Al did his soldering under the sink he said he used "paper or cardboard under the sink" but does not remember specifically what he used. I asked Al to go over with me again exactly what he did in the kitchen area on Thursday. Al said that at about 2:30 -3:00 PM, he put the sink in and put in the Insta-hot. He placed the sink and siliconed around it. He said he then placed the dishwasher in place. He said he drilled a hole for the copper tubing and ran the tubing over to the dishwasher and hooked up a compression fitting to the dishwasher but not the connection under the sink. Al said that he went to hook up the garbage disposal but realized that it would not fit. I asked Al if he left any tools under the sink. He said he left a bag of allen wrenches and small hand tools in a room adjacent to the kitchen. Al said that Kraig was working behind him in the kitchen on a hood vent for the stove. Al said that he had to put all the stops in on Wednesday around noon but was going to have to move two of the stops on Friday. That concluded the second interview.

SCENE EXAMINATION

10. The scene examination began the day of the fire. This officer also returned to the scene and met with Tom Klem and Kevin Murphy of T.J. Klem & Associates representing Chubb Insurance Company for further examination on subsequent days. An examination of the fire scene began with an exterior examination which revealed the following damage. Side A had heavy fire damage extending out of the kitchen window and side door which were both burned away. The main entrance way comprised of mostly glass was also burned away. The left side of side A, windows of the pool table room, were intact and unburned. The dormer located above the kitchen was burned away as was the right center portion of the roof. Another dormer located more center of the roof collapsed into the second floor. There was a hole in the roof next to the left side dormer which remained intact but had some smoke and fire damage extending up and out from it. Side B had fire damage extending from a large dormer located on the second floor. French doors to the pool table room which is located at the A/B corner were intact and unburned. Side C had high fire damage on the second floor extending from a dormer in the center of side C. There was heavy fire damage to two large windows on side C at the C/D corner. The roof was burned away more towards the C/D side. Side D had heavy fire damage on the second floor D/C corner. The kitchen side D window and two other first floor windows had burned away and there was fire extension damage out of all three windows. Prior to beginning an examination of the interior of the building, Trooper Arredondo worked his accelerant detection cannine, Webster, in the building. No accelerants were detected.

11. An interior examination revealed heavy fire damage on the second floor caused by extension of the fire from the first floor. On the first floor, we noted that the gymnasium room located in the C/D corner of the structure had smoke soot and water damage as did a room at the B/C corner of the building. A large room where the floors had just been sanded and stained also had smoke, soot heat, and water damage outside of this room was the main entry way which lead to a spiral staircase to the second floor. This entry was and staircase had heavy fire damage and the second floor was sagging into the entryway from collapse of the roof and dormer above. Fire patterns lead us back towards the A/D corner of the building. A living room with fireplace located behind the kitchen also had heavy fire damage. Fire patterns in this room lead us back to the kitchen.

12. The kitchen had the heaviest and lowest fire damage in the house. All of the cabinets located on the A wall were burned away. The ceiling joists supporting the second floor were also burned away above the kitchen. Cabinets located on the floor and the countertop above them were also burned away as was the interior wall along the A side and the studs behind that wall. We determined that our heaviest and lowest burn was in the area of the sink/ dishwasher. We determined that this was the area of origin of the fire. Corresponding to this area was the heaviest high burn. The ceiling above had burned through to the

Fire Investigation Summary Report

second floor and burned away the dormer located above this area. The only heat source we could locate in this area was an electrical outlet located to the right of the dishwasher while facing it. There was no load on this outlet nor was there any evidence of wiring being spiked by a nail, screw or staple. The wiring appeared to have sufficient slack and was not taught. There were two electrical switch boxes located to the left of the dishwasher. One of these was not live and was to feed power to the garbage disposal and the other was to supply power to the dishwasher and was not yet wired to the dishwasher. Neither of these switch boxes were affected by fire.

13. As we extricated debris we removed countertop tile with no wood beneath it and the steel kitchen sink. Beneath the sink we found an off white canvas tarp which was folded under the sink. The tarp, which appeared relatively new, when unfolded revealed solder on it. The tarp was burned on the top but protected where it was folded. Beneath the tarp we found scorch marks on the wood platform of the cabinet beneath the sink. There were also some small tools located here. The scorch marks appeared to have been made by a torch. There was also a hole burned through the rear wall, which still partially remained behind the sink. The remaining portion of the kitchen plywood wall was removed. Behind that wall, there was charring to the insulation, PVC piping for the drain and melting of the polyethylene vapor barrier covering the insulation behind the plywood wall. Tom Klem told me that he later did a flame test on a sample portion of the polyethylene vapor barrier taken from the house and it ignited easily.

CONCLUSION

14. As a result of our scene examination we were able to determine that our area of origin was beneath the sink. Fire then traveled up and out and got into the wall behind the dishwasher and cabinets burning away the underside of the countertops and cabinets. The fire cause remains undetermined given that the plumbers and job superintendent state there was no soldering being done Thursday. If the plumber, Al Kemp, was soldering on Thursday beneath the sink then the torch would be a competent ignition source to ignite nearby combustibles. His admitted work practice of using paper or cardboard as a backdrop coupled with the fact that there is scorching to the finished wood cabinet beneath the sink and a cloth tarp which has solder on it in the area of origin is suspect. This officer request this case be closed pending any new information that would warrant its re-opening.

Evidence

No Evidence

Photos

Taken By: **Fire Marshal's Office**
Fire Department
Other (see comments)

Description / Explanation / Comments:

Photos taken by Trooper Laurie Covino of Crime Scene Services
Photos taken by LT John Fontaine of the Dedham Fire Department
Photos taken by Tom Clemm and Kevin Murphy representing Chubb Insurance company.

K-9

Description / Explanation / Comments:

Trooper Elkin Arrendondo and AK-9 Webster responded. No accelerants were detected.

Fire Investigation Summary Report

Occupants

No Known Occupants

Injuries

No Known Injuries

Owner

Marino, Roger – 256 Westfield St. Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-686-1195

Marino, Michele – 256 Westfield St. Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-686-1195

Reported By

Cullinane, Robert – 254 Westfield St. Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-983-2009

Discovered By

Marino, Roger – 256 Westfield St. Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-686-1195

Fire Investigation Summary Report

Witnesses

Marino, Roger – 256 Westfield St. Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-686-1195

Cullinane, Robert – 254 Westfield St. Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-883-2009

Kemp, Alfred – 6 Olive Ave Pembroke, MA 00000
DOB: 6-7-60, SSN: Unknown, Phone: 781-294-8086

Sandborg, Martin – 93 Dartmouth Ave Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-326-4055

Shleids, Phillip – 2 Breede Terrace Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-963-2995

Magnussen, Kraig – 31 Hilltop Dr Millis, MA 02054
DOB: Unknown, SSN: Unknown, Phone: 508-376-2385

Barrientos, Jose – 45 Pine St Pawtucket, RI 00000
DOB: 4-16-77, SSN: Unknown, Phone: 401-897-9735

Dicken, Larry – 12 Granite St Hopkinton, MA 02054
DOB: Unknown, SSN: Unknown, Phone: 508-435-3045

Bolteau, Denis – 1 Burgess Lane Dedham, MA 00000
DOB: Unknown, SSN: Unknown, Phone: 781-320-5659

DesJarlais, Francis E (Butch) – 1803 Diamond Hill Rd Cumberland, RI 00000
DOB: Unknown, SSN: Unknown, Phone: 401-333-8957

Johnson, Timothy – 70 Temple St Abington, MA 00000
DOB: 11-7-72, SSN: Unknown, Phone: 781-878-5699

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Daniel Q. Harrington
Direct Phone 215.665.2126
dharrington@cozen.com

July 29, 2005

VIA FEDERAL EXPRESS AND FAX

Stimpson B. Hubbard, Esquire
FINNEGAN, UNDERWOOD, RYAN
& TIERNEY
22 Batterymarch Street
Boston, MA 02109

John J. Ryan Jr., Esquire
RYAN, COUGHLIN & BETKE, LLP
175 Federal Street
Boston, MA 02110

Re: Pacific Indemnity Company v. Kemp, et al.
Civil Action No. 04-11975 (RWZ)
Our File No. 132682

Gentlemen:

Enclosed are expert reports from Lester MacLaughlin and Don Galler. Also enclosed is a disk of photos taken by Donald Galler. A hard copy of Mr. Klem's report will be sent via Fax and Federal Express on Monday.

Although not retained as an expert, we may call Francis M. McGinn of the Massachusetts State Police/State Fire Marshal's Office to testify in accordance with the Fire Investigation Summary Report on Case No. 2002-117-2011.

We may also call the various adjusters, contractors, estimators, and appraisers to testify regarding in accordance with the documentation produced with Plaintiff's Initial Disclosures in this matter.

PLAINTIFF'S EXHIBIT
B

As discussed with Mr. Hubbard, we may have an additional witness on damages, only. If so, we will provide that expert's report by the end of August, and will allow you both corresponding additional time to respond. Mr. Hubbard was amenable to this. I left a message with Mr. Ryan on July 28 to discuss, but have not heard from him. I trust that he will advise if there is any problem.

Very truly yours,

COZEN O'CONNOR

DANIEL Q. HARRINGTON

DQH/ada
Enclosures

cc: Patricia Healy (w/enc.)(Claim No. 11509588-06)

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FROM: Daniel Q. Harrington TIMEKEEPER NO.: 144

NO. OF PAGES (INCLUDING COVER): 39 FILE NAME: MARINO

DATE: July 29, 2005 FILE NO. 132682

RECIPIENT(S)	PHONE	FAX
John J. Ryan Jr., Esq.	617-988-8050	617-988-8005
Stimpson B. Hubbard, Esq.	617-348-9200	617-482-6677

MESSAGE:

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Stimpson B. Hubbard, Esq.	617-348-9200	617-482-6677

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NFPA 921

Guide for

Fire and Explosion Investigations

2004 Edition

This edition of NFPA 921, *Guide for Fire and Explosion Investigations,* was prepared by the Technical Committee on Fire Investigations and acted on by NFPA at its November Association Technical Meeting held November 15–19, 2003, in Reno, NV. It was issued by the Standards Council on January 16, 2004, with an effective date of February 5, 2004, and supersedes all previous editions.

This edition of NFPA 921 was approved as an American National Standard on January 16, 2004.

Origin and Development of NFPA 921

NFPA 921, *Guide for Fire and Explosion Investigations,* was developed by the Technical Committee on Fire Investigations to assist in improving the fire investigation process and the quality of information on fires resulting from the investigative process. The guide is intended for use by both public sector employees who have statutory responsibility for fire investigation and private sector persons conducting investigations for insurance companies or litigation purposes. The goal of the committee is to provide guidance to investigators that is based on accepted scientific principles or scientific research.

The first edition of the document, issued by NFPA in 1992, focused largely on the determination of origin and cause of fires and explosions involving structures. The second edition of the document included revised chapters on the collection and handling of physical evidence, safety, and explosions. NFPA 907M, *Manual for the Determination of Electrical Fire Causes,* was withdrawn as an individual document and was integrated with revisions into this document as a separate chapter. Elements of NFPA 907M that relate to other chapters of this document were relocated appropriately. New chapters dealing with the investigation of motor vehicle fires, management of major investigations, incendiary fires, and appliances were added.

The third edition of the document included a new chapter on fuel gas systems in buildings and the impact of fuel gases on fire and explosion investigations. The chapter on electricity and fire was rewritten to improve organization, clarify terminology, and add references. In the chapter on fire patterns, several sections were revised. Other revisions were made in the chapter on physical evidence on the subject of preservation of the fire scene and of physical evidence. The edition also included new text regarding ignitable liquid detection canine/handler teams.

The fourth edition of this document included new chapters on building systems, fire-related human behavior, failure analysis and analytical tools, fire and explosion deaths and injuries, and wildfire investigations. An updated chapter on motor vehicle fires was written. The document was organized to group chapters into subjects that made it more usable.

The fifth edition of this document includes a revision of the document to comply with the new NFPA *Manual of Style* and a new chapter titled, "Analyzing the Incident for Cause and Responsibility," a rewrite of the chapter on Legal Considerations, and a revision in the chapter on Recording the Scene.

PLAINTIFF'S EXHIBIT
C

NFPA 921

Guide for

Fire and Explosion Investigations

2004 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex C lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope. This document is designed to assist individuals who are charged with the responsibility of investigating and analyzing fire and explosion incidents and rendering opinions as to the origin, cause, responsibility, or prevention of such incidents.

1.2 Purpose.

1.2.1 The purpose of this document is to establish guidelines and recommendations for the safe and systematic investigation or analysis of fire and explosion incidents. Fire investigation or analysis and the accurate listing of causes is fundamental to the protection of lives and property from the threat of hostile fire or explosions. It is through an efficient and accurate determination of the cause and responsibility that future fire incidents can be avoided. This document has been developed as a model for the advancement and practice of fire and explosion investigation, fire science, technology, and methodology.

1.2.2 Proper determination of fire origin and cause is also essential for the meaningful compilation of fire statistics. Accurate statistics form part of the basis of fire prevention codes, standards, and training.

1.3 Application. This document is designed to produce a systematic, working framework or outline by which effective fire and explosion investigation and origin and cause analysis can be accomplished. It contains specific procedures to assist in the investigation of fires and explosions. These procedures represent the judgment developed from the NFPA consensus process system, that if followed can improve the probability of reaching sound conclusions. Deviations from these procedures, however, are not necessarily wrong or inferior but need to be justified.

1.3.1 The reader should note that frequently the phrase *fire investigation* is used in this document when the context indicates that the relevant text refers to the investigation of both fires and explosions.

1.3.2 As every fire and explosion incident is in some way different and unique from any other, this document is not designed to encompass all the necessary components of a complete investigation or analysis of any one case.

1.3.3 Not every portion of this document may be applicable to every fire or explosion incident. It is up to investigators (depending on their responsibility, as well as the purpose and scope of their investigation) to apply the appropriate recommended procedures in this guide to a particular incident.

1.3.4 In addition, it is recognized that time and resource limitations or existing policies may limit the degree to which the recommendations in this document will be applied in a given investigation. This document has been developed as a model for the advancement and practice of fire and explosion investigation, fire science, technology, and methodology.

1.4* Units of Measure. Metric units of measurement in this guide are in accordance with the modernized metric system known as the International System of Units (SI). The unit of liter is outside of but recognized by SI and is commonly used in international fire protection. These units are listed in Table 1.4.

Table 1.4 SI Units and Equivalent U.S. Customary Units

SI	U.S.
2.54 cm	1 in.
0.3048 m	1 ft
0.09290 m^2	1 ft^2
28.32 L	1 ft^3
0.02832 m^3	1 ft^3
3.785 L	1 U.S. gal
0.4536 kg	1 lb
28.35 g	1 oz (weight)
0.3048 m/s	1 ft/s
16.02 kg/m^3	1 lb/ft^3
0.06308 L/s	1 gpm
Pressure exerted by 760 millimeters of mercury of standard density at 0°C, 14.7 lb/in.^{2} (101.3 kPa).	1 atmosphere
1.055 kW	1 Btu/s
1055 J	1 Btu
0.949 Btu/s	1 kW
248.8 Pa = 0.036 psi	1 in. w.c.
1 atmosphere	27.7 in. w.c.

3.3.88 High Explosive. A material that is capable of sustaining a reaction front that moves through the unreacted material at a speed equal to or greater than that of sound in that medium [typically 1000 m/s (3000 ft/sec)]; a material capable of sustaining a detonation. *(See also Detonation.)*

3.3.89 High-Order Explosion. A rapid pressure rise or high-force explosion characterized by a shattering effect on the confining structure or container and long missile distances.

3.3.90 Hypergolic Material. Any substance that will spontaneously ignite or explode upon exposure to an oxidizer.

3.3.91 Ignitable Liquid. Any liquid or the liquid phase of any material that is capable of fueling a fire, including a flammable liquid, combustible liquid, or any other material that can be liquefied and burned.

3.3.92 Ignition. The process of initiating self-sustained combustion.

3.3.93 Ignition Energy. The quantity of heat energy that should be absorbed by a substance to ignite and burn.

3.3.94* Ignition Temperature. Minimum temperature a substance should attain in order to ignite under specific test conditions.

3.3.95 Ignition Time. The time between the application of an ignition source to a material and the onset of self-sustained combustion.

3.3.96 Inductive Reasoning. The process by which a person starts from a particular experience and proceeds to generalizations.

3.3.97 Isochar. A line on a diagram connecting points of equal char depth.

3.3.98 Joule. The preferred SI unit of heat, energy or work; there are 4.184 joules in a calorie, and 1055 joules in a British thermal unit (Btu). A watt is a joule/second. *(See also 3.3.19, British Thermal Unit, and 3.3.21, Calorie.)*

3.3.99 Kilowatt. A measurement of energy release rate.

3.3.100 Kindling Temperature. See 3.3.94, Ignition Temperature.

3.3.101 Layering. The systematic process of removing debris from the top down and observing the relative location of artifacts at the fire scene.

3.3.102 Low Explosive. An explosive that has a reaction velocity of less than 1000 m/s (3000 ft/sec).

3.3.103 Low-Order Explosion. A slow rate of pressure rise or low-force explosion characterized by a pushing or dislodging effect on the confining structure or container and by short missile distances.

3.3.104 Material First Ignited. The fuel that is first set on fire by the heat of ignition; to be meaningful, both a type of material and a form of material should be identified.

3.3.105 Noncombustible Material. A material that, in the form in which it is used and under the condition anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Also called *incombustible material* (not preferred).

3.3.106 Nonflammable. (1) Not readily capable of burning with a flame. (2) Not liable to ignite and burn when exposed to flame. Its antonym is *flammable.*

3.3.107 Ohm. The unit of electrical resistance (R) that measures the resistance between two points of a conductor when a constant difference of potential of one volt between these two points produces in this conductor a current of one ampere.

3.3.108 Origin. See 3.3.115, Point of Origin, or 3.3.9, Area of Origin.

3.3.109 Overcurrent. Any current in excess of the rated current of equipment or the ampacity of a conductor; it may result from an overload *(see 3.3.110)*, short circuit, or ground fault.

3.3.110* Overload. Operation of equipment in excess of normal, full-load rating or of a conductor in excess of rated ampacity, which, when it persists for a sufficient length of time, would cause damage or dangerous overheating.

3.3.111 Oxygen Deficiency. Insufficiency of oxygen to support combustion. *(See also Ventilation-Controlled Fire.)*

3.3.112 Piloted Ignition Temperature. See 3.3.94, Ignition Temperature.

3.3.113* Plastic. Any of a wide range of natural or synthetic organic materials of high molecular weight that can be formed by pressure, heat, extrusion, and other methods into desired shapes.

3.3.114 Plume. The column of hot gases, flames, and smoke rising above a fire; also called *convection column, thermal updraft,* or *thermal column.*

3.3.115 Point of Origin. The exact physical location where a heat source and a fuel come in contact with each other and a fire begins.

3.3.116 Premixed Flame. A flame for which the fuel and oxidizer are mixed prior to combustion, as in a laboratory Bunsen burner or a gas cooking range; propagation of the flame is governed by the interaction between flow rate, transport processes, and chemical reaction.

3.3.117 Preservation. Application or use of measures to prevent damage, change or alteration, or deterioration.

3.3.118 Products of Combustion. See 3.3.31, Combustion Products.

3.3.119 Proximate Cause. The cause that directly produces the effect without the intervention of any other cause.

3.3.120 Pyrolysis. The chemical decomposition of a compound into one or more other substances by heat alone; pyrolysis often precedes combustion.

3.3.121 Pyrophoric Material. Any substance that spontaneously ignites upon exposure to atmospheric oxygen.

3.3.122 Radiant Heat. Heat energy carried by electromagnetic waves that are longer than light waves and shorter than radio waves; radiant heat (electromagnetic radiation) increases the sensible temperature of any substance capable of absorbing the radiation, especially solid and opaque objects.

3.3.123 Radiation. Heat transfer by way of electromagnetic energy.

3.3.124 Rate of Heat Release. See 3.3.87, Heat Release Rate.

3.3.125 Rekindle. A return to flaming combustion after apparent but incomplete extinguishment.

3.3.126 Responsibility. The accountability of a person or other entity for the event or sequence of events that caused the fire or explosion, spread of the fire, bodily injuries, loss of life, or property damage.

3.3.127 Risk. The degree of peril; the possible harm that might occur that is represented by the statistical probability or quantitative estimate of the frequency or severity of injury or loss.

3.3.128 Rollover. See 3.3.65, Flameover.

3.3.129 Scientific Method. The systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of a hypothesis.

3.3.130 Seat of Explosion. A craterlike indentation created at the point of origin of an explosion.

3.3.131 Seated Explosion. An explosion with a highly localized point of origin, such as a crater.

3.3.132 Secondary Explosion. Any subsequent explosion resulting from an initial explosion.

3.3.133 Self-Heating. The result of exothermic reactions, occurring spontaneously in some materials under certain conditions, whereby heat is generated at a rate sufficient to raise the temperature of the material.

3.3.134 Self-Ignition. Ignition resulting from self-heating. Synonymous with spontaneous ignition.

3.3.135 Self-Ignition Temperature. The minimum temperature at which the self-heating properties of a material lead to ignition.

3.3.136 Short Circuit. An abnormal connection of low resistance between normal circuit conductors where the resistance is normally much greater; this is an overcurrent situation but it is not an overload.

3.3.137 Smoke. The airborne solid and liquid particulates and gases evolved when a material undergoes pyrolysis or combustion, together with the quantity of air that is entrained or otherwise mixed into the mass. [318:3.3]

3.3.138 Smoke Condensate. The condensed residue of suspended vapors and liquid products of incomplete combustion.

3.3.139 Smoke Explosion. See 3.3.14, Backdraft.

3.3.140 Smoldering. Combustion without flame, usually with incandescence and smoke.

3.3.141 Soot. Black particles of carbon produced in a flame.

3.3.142 Spalling. Chipping or pitting of concrete or masonry surfaces.

3.3.143 Spark. A moving particle of solid material that emits radiant energy due either to its temperature or the process of combustion on its surface. [654:15]

3.3.144 Spoliation. Loss, destruction, or material alteration of an object or document that is evidence or potential evidence in a legal proceeding by one who has the responsibility for its preservation.

3.3.145* Spontaneous Heating. Process whereby a material increases in temperature without drawing heat from its surroundings.

3.3.146 Spontaneous Ignition. Initiation of combustion of a material by an internal chemical or biological reaction that has produced sufficient heat to ignite the material.

3.3.147 Suppression. The sum of all the work done to extinguish a fire, beginning at the time of its discovery.

3.3.148 Target Fuel. A fuel that is subject to ignition by thermal radiation such as from a flame or a hot gas layer.

3.3.149* Temperature. The degree of sensible heat of a body as measured by a thermometer or similar instrument.

3.3.150 Thermal Column. See 3.3.114, Plume.

3.3.151* Thermal Expansion. The proportional increase in length, volume, or superficial area of a body with rise in temperature.

3.3.152 Thermal Inertia. The properties of a material that characterize its rate of surface temperature rise when exposed to heat; related to the product of the material's thermal conductivity (k), its density (ρ), and its heat capacity (c).

3.3.153 Thermoplastic. Plastic materials that soften and melt under exposure to heat and can reach a flowable state.

3.3.154 Thermoset Plastics. Plastic materials that are hardened into a permanent shape in the manufacturing process and are not commonly subject to softening when heated; typically form char in a fire.

3.3.155 Time Line. Graphic representation of the events in a fire incident displayed in chronological order.

3.3.156 Upper Layer. See 3.3.24, Ceiling Layer.

3.3.157 Vapor. The gas phase of a substance, particularly of those that are normally liquids or solids at ordinary temperatures. *(See also 3.3.79, Gas.)*

3.3.158 Vapor Density. The ratio of the average molecular weight of a given volume of gas or vapor to the average molecular weight of an equal volume of air at the same temperature and pressure.

3.3.159 Vent. An opening for the passage of, or dissipation of, fluids, such as gases, fumes, smoke, and the like.

3.3.160 Ventilation. Circulation of air in any space by natural wind or convection or by fans blowing air into or exhausting air out of a building; a fire-fighting operation of removing smoke and heat from the structure by opening windows and doors or making holes in the roof.

3.3.161 Ventilation-Controlled Fire. A fire in which the heat release rate or growth is controlled by the amount of air available to the fire.

3.3.162 Venting. The escape of smoke and heat through openings in a building.

3.3.163 Volt (V). The unit of electrical pressure (electromotive force) represented by the symbol "E"; the difference in potential required to make a current of one ampere flow through a resistance of one ohm.

3.3.164 Watt (W). Unit of power, or rate of work, equal to one joule per second, or the rate of work represented by a current of one ampere under the potential of one volt.

Chapter 4 Basic Methodology

4.1 Nature of Fire Investigations. A fire or explosion investigation is a complex endeavor involving skill, technology, knowledge, and science. The compilation of factual data, as well as an analysis of those facts, should be accomplished objectively and truthfully. The basic methodology of the fire investigation should rely on the use of a systematic approach and attention to all relevant details. The use of a systematic approach often will uncover new factual data for analysis, which may require previous conclusions to be reevaluated. With few exceptions, the proper methodology for a fire or explosion investigation is to first determine and establish the origin(s), then investigate the cause: circumstances, conditions, or agencies that brought the ignition source, fuel, and oxidant together.

4.2 Systematic Approach. The systematic approach recommended is that of the scientific method, which is used in the physical sciences. This method provides for the organizational and analytical process desirable and necessary in a successful fire investigation.

4.3 Relating Fire Investigation to the Scientific Method. The scientific method *(see Figure 4.3)* is a principle of inquiry that forms a basis for legitimate scientific and engineering processes, including fire incident investigation. It is applied using the following steps.

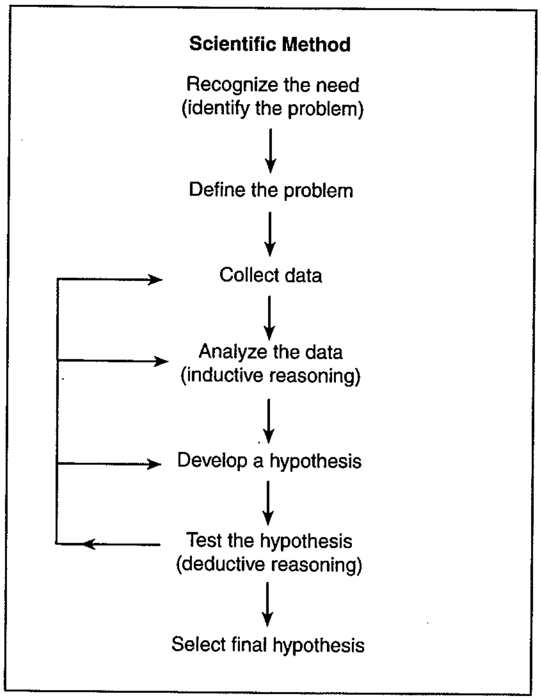

FIGURE 4.3 Use of the Scientific Method.

4.3.1 Recognize the Need. First, one should determine that a problem exists. In this case, a fire or explosion has occurred and the cause should be determined and listed so that future, similar incidents can be prevented.

4.3.2 Define the Problem. Having determined that a problem exists, the investigator or analyst should define in what manner the problem can be solved. In this case, a proper origin and cause investigation should be conducted. This is done by an examination of the scene and by a combination of other data collection methods, such as the review of previously conducted investigations of the incident, the interviewing of witnesses or other knowledgeable persons, and the results of scientific testing.

4.3.3 Collect Data. Facts about the fire incident are now collected by observation, experiment, or other direct data-gathering means. The data collected is called empirical data because it is based on observation or experience and is capable of being verified.

4.3.4* Analyze the Data (Inductive Reasoning). All of the collected and observed information is analyzed by inductive reasoning: the process in which the total body of empirical data collected is carefully examined in the light of the investigator's knowledge, training, experience, and expertise. Subjective or speculative information cannot be included in the analysis, only facts that can be proven clearly by observation or experiment.

4.3.5 Develop a Hypothesis. Based on the data analysis, the investigator should now produce a hypothesis or group of hypotheses to explain the origin and cause of the fire or explosion incident. This hypothesis should be based solely on the empirical data that the investigator has collected.

4.3.6* Test the Hypothesis (Deductive Reasoning). The investigator does not have a truly provable hypothesis unless it can stand the test of careful and serious challenge. Testing of the hypothesis is done by the principle of deductive reasoning, in which the investigator compares his or her hypothesis to all known facts. *(See 3.3.35, Deductive Reasoning.)* This testing of the hypothesis may be either cognitive or experimental. If the hypothesis cannot withstand an examination by deductive reasoning, it should be discarded as not provable and a new hypothesis should be tested. This test may include the collection of new data or the reanalysis of existing data. This process needs to be continued until all feasible hypotheses have been tested. Otherwise the fire cause should be listed as "undetermined."

4.3.7 Avoid Presumption of Cause. Until data have been collected, no specific hypothesis can be reasonably formed or treated. All fires, however, should be approached by the investigator without presumption.

4.4 Basic Method of a Fire Investigation. Using the scientific method in most fire or explosion incidents should involve the following five major steps from inception through final analysis.

4.4.1 Receiving the Assignment. The investigator should be notified of the incident, what his or her role will be, and what he or she is to accomplish. For example, the investigator should know if he or she is expected to determine the origin, cause, and responsibility; produce a written or oral report; prepare for criminal or civil litigation; make suggestions for code enforcement, code promulgation, or changes; make suggestions to manufacturers, industry associations, or government agency action; or determine some other results.

4.4.2 Preparing for the Investigation. The investigator should marshal his or her forces and resources and plan the conduct of the investigation. Preplanning at this stage can greatly increase the efficiency and therefore the chances for success of the overall investigation. Estimating what tools, equipment, and personnel (both laborers and experts) will be needed can make the initial scene investigation, as well as subsequent investigative examinations and analyses, go more smoothly and be more productive.

4.4.3 Conducting the Investigation.

4.4.3.1 The investigator should conduct an examination of the scene if it is available and collect data necessary to the analysis. The actual investigation may take and include different steps and procedures, and these will be determined by the purpose of the investigation assignment. These steps and procedures are described in detail elsewhere in the document. A typical fire or explosion investigation may include all or some of the following: a scene inspection or review of previous scene documentation done by others; scene documentation through photography and diagramming; evidence recognition, documentation, and preservation; witness interviews; review and analysis of the investigations of others; and identification and collection of data or information from other appropriate sources.

4.4.3.2 It is during this phase of the investigation that the data necessary for the analysis of the incident will be collected.

4.4.4 Collecting and Preserving Evidence. Valuable physical evidence should be recognized, documented, properly collected, and preserved for further testing and evaluation or courtroom presentation.

4.4.5 Analyzing the Incident. All collected and available data should be analyzed using the principles of the scientific method. An incident scenario or failure analysis should be described, explaining the origin, cause, fire spread, and responsibility for the incident.

4.4.6 Conclusions. Conclusions should be drawn according to the principles expressed in this guide and reported appropriately.

4.5 Reporting Procedure. The reporting procedure may take many written or oral forms, depending on the specific responsibility of the investigator. Pertinent information should be reported in a proper form and forum to help prevent recurrence.

Chapter 5 Basic Fire Science

5.1 Chemistry of Combustion.

5.1.1 General. The fire investigator should have a basic understanding of ignition and combustion principles and should be able to use them to help in interpretation of evidence at the fire scene and in the development of conclusions regarding the origin and causes of the fire. The body of knowledge associated with combustion and fire would easily fill several textbooks. The discussion presented in this section should be considered introductory. The user of this guide is urged to consult the reference material listed Chapter 2, Annex B, and Annex C for additional details.

5.1.2 Fire Tetrahedron. The combustion reaction can be characterized by four components: the fuel, the oxidizing agent, the heat, and the uninhibited chemical chain reaction. These four components have been classically symbolized by a four-sided solid geometric form called a tetrahedron *(see Figure 5.1.2)*. Fires can be prevented or suppressed by controlling or removing one or more of the sides of the tetrahedron.

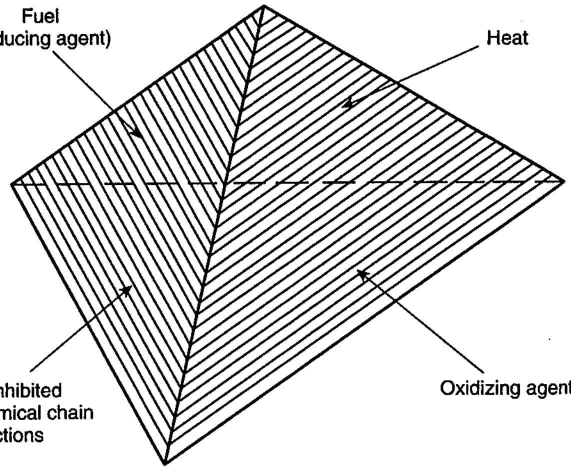

FIGURE 5.1.2 Fire Tetrahedron.

5.1.2.1 Fuel. A fuel is any substance that can undergo combustion. The majority of fuels encountered are organic, which simply means that they are carbon-based and may contain other elements such as hydrogen, oxygen, and nitrogen in varying ratios. Examples of organic fuels include wood, plastics, gasoline, alcohol, and natural gas. Inorganic fuels contain no carbon and include combustible metals, such as magnesium or sodium. All matter can exist in one of three phases: solid, liquid, or gas. The phase of a given material depends on the temperature and pressure and can change as conditions vary. If cold enough, carbon dioxide, for example, can exist as a solid (dry ice). The normal phase of a material is that which exists at standard conditions of temperature [21°C (70°F)] and pressure 101.6 kPa (14.7 psi) or 1 atmosphere at sea level].

5.1.2.1.1 Combustion of liquid fuels and most solid fuels takes place above the fuel surface in a region of vapors created by heating the fuel surface. The heat can come from the ambient conditions, from the presence of an ignition source, or from exposure to an existing fire. The application of heat causes vapors or pyrolysis products to be released into the atmosphere, where they can burn if in the proper mixture with an oxidizer and if a competent ignition source is present or if the fuel's autoignition temperature is reached. Ignition is discussed in Section 5.3.

5.1.2.1.2 Some solid materials can undergo a smoldering reaction, where oxygen reacts directly with solid material. Smoldering can be the initial or the final stage of burning. Sometimes smoldering combustion breaks into flame; on other occasions smoldering continues through the total course of events.

5.1.2.1.3 Gaseous fuels do not require vaporization or pyrolysis before combustion can occur. Only the proper mixture with an oxidizer and an ignition source are needed.

5.1.2.1.4 The form of a solid or liquid fuel is an important factor in its ignition and burning rate. For example, a fine wood dust ignites easier and burns faster than a block of wood. Some flammable liquids, such as diesel oil, are difficult to ignite in a pool but can ignite readily and burn rapidly when in the form of a fine spray or mist.

5.1.2.1.5 For the purposes of the following discussion, the term *fuel* is used to describe vapors and gases rather than solids.

5.1.2.2 Oxidizing Agent. In most fire situations, the oxidizing agent is the oxygen in the earth's atmosphere. Fire can occur in the absence of atmospheric oxygen, when fuels are mixed with chemical oxidizers. Many chemical oxidizers contain readily released oxygen. Ammonium nitrate fertilizer (NH_4NO_3), potassium nitrate (KNO_3), and hydrogen peroxide (H_2O_2) are examples.

5.1.2.2.1* Normal air contains 21 percent oxygen. In oxygen-enriched atmospheres, such as in areas where medical oxygen is in use or in high-pressure diving or medical chambers, combustion is greatly accelerated. Materials that resist ignition or burn slowly in air can burn vigorously when additional oxygen is present. Combustion can be initiated in atmospheres containing very low percentages of oxygen, depending on the fuel involved. As the temperature of the environment increases, the oxygen requirements are further reduced. While flaming combustion can occur at concentrations as low as 14 to 16 percent oxygen in air at room temperatures of 21°C (70°F), flaming combustion can continue at close to 0 percent oxygen under postflashover temperature conditions. Also, smoldering combustion, once initiated, can continue in a low-oxygen environment even when the surrounding environment is at a relatively low temperature. The hotter the environment, the less oxygen is required. This latter condition is why wood and other materials can continue to be consumed, even though the fire is in a closed compartment with low oxygen content. Fuels that are enveloped in a layer of hot, oxygen-depleted combustion products in the upper portion of a room can also be consumed.

5.1.2.2.2 It should be noted that certain gases can form flammable mixtures in atmospheres other than air or oxygen. One example is a mixture of hydrogen and chlorine gas.

5.1.2.2.3 For combustion to take place, the fuel vapor or gas and the oxidizer should be mixed in the correct ratio. In the case of solids and liquids, the pyrolysis products or vapors disperse from the fuel surface and mix with the air. As the distance from the fuel source increases, the concentration of the vapors and pyrolysis products decreases. The same process acts to reduce the concentration of a gas as the distance from the source increases.

5.1.2.2.4 Fuel burns only when the fuel/air ratio is within certain limits known as the flammable (explosive) limits. In cases where fuels can form flammable mixtures with air, there is a minimum concentration of vapor in air, below which propagation of flame does not occur. This is called the *lower flammable limit.* There is also a maximum concentration, called the *upper flammable limit,* above which flame will not propagate. These limits are generally expressed in terms of percentage by volume of vapor or gas in air.

5.1.2.2.5 The flammable limits reported are usually corrected to a temperature of 0°C (32°F) and 1 atmosphere. Increases in temperature and pressure result in reduced lower flammable limits, possibly below 1 percent, and increased upper flammable limits. Upper limits for some fuels can approach 100 percent at high temperatures. A decrease in temperature and pressure will have the opposite effect. Caution should be exercised when using the values for flammability limits found in the literature. The reported values are often based on a single experimental apparatus that does not necessarily account for conditions found in practice.

5.1.2.2.6 The range of mixtures between the lower and upper limits is called the flammable (explosive) range. For example, the lower limit of flammability of gasoline at ordinary temperatures and pressures is 1.4 percent, and the upper limit is 7.6 percent. All concentrations by volume falling between 1.4 and 7.6 percent will be in the flammable (explosive) range. All other factors being equal, the wider the flammable range, the greater the likelihood of the mixture coming in contact with an ignition source and thus the greater the hazard of the fuel. Acetylene, with a flammable range between 2.5 and 100 percent, and hydrogen, with a range from 4 to 75 percent, are considered very dangerous and very likely to be ignited when released.

5.1.2.2.7 Every fuel–air mixture has an optimum ratio at which point the combustion will be most efficient. This ratio occurs at or near the mixture known by chemists as the stoichiometric ratio. When the amount of air is in balance with the amount of fuel (i.e., after burning there is neither unused fuel nor unused air), the burning is referred to as stoichiometric. This condition rarely occurs in fires except in certain types of gas fires. *(See 21.8.2.1.)*

5.1.2.2.8 Fires usually have either an excess of air or an excess of fuel. When there is an excess of air, the fire is considered to be fuel controlled. When there is more fuel present than air, a condition that occurs frequently in well-developed room or compartment fires, the fire is considered to be ventilation controlled.

5.1.2.2.9 In a fuel-controlled compartment fire, all the burning will take place within the compartment, and the products of combustion will be much the same as burning the same material in the open. In a ventilation-controlled compartment fire, the combustion inside the compartment will be incomplete. The burning rate will be limited by the amount of air entering the compartment. This condition will result in unburned fuel and other products of incomplete combustion leaving the compartment and spreading to adjacent spaces. Ventilation-controlled fires can produce massive amounts of carbon monoxide.

5.1.2.2.10 If the gases immediately vent out a window or into an area where sufficient oxygen is present, they will ignite and burn when the gases are above their ignition temperatures. If the venting is into an area where the fire has caused the atmosphere to be deficient in oxygen, such as a thick layer of smoke in an adjacent room, it is likely that flame extension in that direction will cease, although the gases can be hot enough to cause charring and extensive heat damage.

5.1.2.3 Heat. The heat component of the tetrahedron represents heat energy above the minimum level necessary to release fuel vapors and cause ignition. Heat is commonly defined in terms of intensity or heating rate (Btu/sec or kilowatts) or as the total heat energy received over time (Btu or kilojoules). In a fire, heat produces fuel vapors, causes ignition, and promotes fire growth and flame spread by maintaining a continuous cycle of fuel production and ignition.

5.1.2.4 Uninhibited Chemical Chain Reaction.

5.1.2.4.1 Combustion is a complex set of chemical reactions that results in the rapid oxidation of a fuel, producing heat, light, and a variety of chemical by-products. Slow oxidation, such as rust or the yellowing of newspaper, produces heat so slowly that combustion does not occur. Self-sustained combustion occurs when sufficient excess heat from the exothermic reaction radiates back to the fuel to produce vapors and cause ignition in the absence of the original ignition source. For a detailed discussion of ignition, see Section 5.3.

5.1.2.4.2 Combustion of solids can occur by two mechanisms: flaming and smoldering. Flaming combustion takes place in the gas or vapor phase of a fuel. With solid and liquid fuels, this combustion is above the surface. Smoldering is a surface-burning phenomenon with solid fuels and involves a lower rate of heat release and no visible flame. Smoldering fires frequently make a transition to flaming after sufficient total energy has been produced, or when airflow is present to speed up the combustion rate.

5.2 Heat Transfer.

5.2.1 General. Heat transfer is classically defined as the transport of heat energy from one point to another caused by a temperature difference between those points. The transfer of heat is a major factor in fires and has an effect on ignition, growth, spread, decay (reduction in energy output), and extinction. Heat transfer is also responsible for much of the physical evidence used by investigators who attempt to establish a fire's origin and cause.

5.2.1.1 It is important to distinguish between heat and temperature. Temperature is a measure that expresses the degree of molecular activity of a material compared to a reference point, such as the freezing point of water. Heat is the energy that is needed to maintain or change the temperature of an object. When heat energy is transferred to an object, the temperature increases. When heat is transferred away, the temperature decreases.

5.2.1.2 Heat is always transferred from the high-temperature mass to the low-temperature mass. Heat transfer is measured in terms of energy flow per unit of time (Btu/sec or kilowatts). The greater the temperature difference between the objects, the more energy is transferred per unit of time and the higher the heat transfer rate is. Temperature can be compared to the pressure in a fire hose and heat or energy transfer to the waterflow in gallons per minute.

5.2.1.3 Heat transfer is accomplished by three mechanisms: conduction, convection, and radiation. All three mechanisms play a role in the investigation of a fire, and an understanding of each is necessary.

5.2.2 Conduction. Conduction is the form of heat transfer that takes place within solids when one portion of an object is heated. Energy is transferred from the heated area to the unheated area at a rate dependent on the difference in temperature and the physical properties of the material. The properties are the thermal conductivity (k), the density (ρ), and the heat capacity (c). The thermal conductivity (k) of a material is a measure of the amount of heat that will flow across a unit area with a temperature gradient of 1 degree per unit of length (W/m-K, Btu/hr-ft-°F). The heat capacity (specific heat) of a material is a measure of the amount of heat necessary to raise the temperature of a unit mass 1 degree, under specified conditions (J/kg-K, Btu/lb-°F).

5.2.2.1 If thermal conductivity (k) is high, the rate of heat transfer through the material is high. Metals have high thermal conductivities (k), while plastics or glass have low thermal conductivity (k) values. Other properties (k and c) being equal, high-density (ρ) materials conduct heat faster than low-density materials. Therefore, low-density materials make good insulators. Similarly, materials with a high heat capacity (c) require more energy to raise the temperature than materials with low heat capacity values.

5.2.2.2 When one portion of a solid is exposed to a high temperature and another portion of that solid is at a lower temperature, then heat energy will be transferred into and through the solid from the higher to the lower temperature areas. Initially, the heat energy moving through the solid will raise the temperature at all interior points to some level of temperature between the extreme high and extreme low. When the temperatures at all interior points have stopped increasing, the temperature and heat transfer within the solid is said to be in a steady state thermal condition. During steady state heat transfer, a condition that is rare in most fire scenarios, thermal conductivity (k) is the dominant heat transfer property. When solids are exposed to temperatures that are continuously changing, a more common condition, the result is changing rates of heat transfer. During this period, all three properties — thermal conductivity (k), density (ρ), and heat capacity (c) — play a role. Taken together, these properties are commonly called the *thermal inertia* of a material and are expressed in terms of k, ρ, and c. Table 5.2.2.2 provides data for some common materials.

Table 5.2.2.2 Thermal Properties of Selected Materials

Material	Thermal Conductivity (k) (W/m-K)	Density (ρ) (kg/m^3)	Heat Capacity (c_p) (J/kg-K)
Copper	387	8940	380
Concrete	0.8–1.4	1900–2300	880
Gypsum plaster	0.48	1440	840
Oak	0.17	800	2380
Pine (yellow)	0.14	640	2850
Polyethylene	0.35	940	1900
Polystyrene (rigid)	0.11	1100	1200
Polyvinylchloride	0.16	1400	1050
Polyurethane*	0.034	20	1400

*Typical values, properties vary.

Source: Drysdale, *An Introduction to Fire Dynamics*, 2nd ed., p. 33.

5.2.2.3 The impact of the thermal inertia on the rise in temperature in a space or on the material in it is not constant through the duration of a fire. Eventually, as the materials involved reach a constant temperature, the effects of density (ρ) and heat capacity (c) become insignificant relative to thermal conductivity. Therefore, thermal inertia of a material is most important at the initiation and early stages of a fire (preflashover).

5.2.2.4 Conduction of heat into a material as it affects its surface temperature is an important aspect of ignition. Thermal inertia is an important factor in how fast the surface temperature will rise. The lower the thermal inertia of the material, the faster the surface temperature will rise.

5.2.2.5 Conduction is also a mechanism of fire spread. Heat conducted through a metal wall or along a pipe or metal beam can cause ignition of combustibles in contact with the heated metals. Conduction through metal fasteners such as nails, nail plates, or bolts can result in fire spread or structural failure.

5.2.3 Convection. Convection is the transfer of heat energy by the movement of heated liquids or gases from the source of heat to a cooler part of the environment.

and with increasing distance from the plume. Stated another way, the higher the ceiling or the farther away the device, the larger the heat output from the fire will be at the time the device responds. These factors should be considered when attempting to understand why a fire appears to be larger than expected at the time of alarm or sprinkler operation.

5.5.4.2 Compartment Fires and Flashover. The heat output from a fire in a compartment is confined by walls as well as the ceiling. The closer proximity of the walls results in a more rapid development of the hot gas layer at the ceiling and the creation of a much deeper layer. Figure 5.5.4.2 depicts a room with a door opening. There are two fuel packages in the room; one is the item first ignited, and the other is the "target" fuel or second item ignited. Initially, the ceiling layer will be thin, resembling the no-wall situation. However, as the gases reach the walls and can no longer spread horizontally, the bottom of the layer will descend and become uniform in depth. Smoke detectors in the compartment of origin will generally respond early in this stage of fire development.

5.5.4.2.1 When the smoke level reaches the top of the door opening, as illustrated in Figure 5.5.4.2.1, it will begin to flow out of the compartment. If the rate of smoke production does not exceed the rate of smoke flow out of the compartment, the ceiling layer will not descend further.

5.5.4.2.2 If the fire grows in size, the bottom of the ceiling layer will continue to descend, the temperature of the hot smoke and gases will increase, and radiant heat from the layer will begin to heat the unignited target fuel, as shown in Figure 5.5.4.2.2. A well-defined flow pattern will be established at the opening, with the hot combustion products flowing out the top and cool air flowing into the compartment under the smoke layer.

5.5.4.2.3 At the start of this stage of burning, there is sufficient air to burn all of the materials being pyrolyzed. This is referred to as *fuel-controlled burning*. As the burning progresses, the availability of air may continue to be sufficient and the fire may continue to have sufficient oxygen even as it grows. Normally, this would be a location that had a large door or window opening as compared to fuel surface burning. In such cases, the gases collected at the upper portion of the room, while hot, will contain significant oxygen and relatively small amounts of unburned fuel.

5.5.4.2.4 If the amount of air resident in the room, plus that transported to the room through the HVAC system or drawn in through openings, is not sufficient to burn all of the combustibles being pyrolyzed by the fire, the fire will shift from fuel control to ventilation control. In that situation, the ceiling layer will contain unburned products of combustion such as hydrocarbon vapors, carbon monoxide, and soot. In general, there will be insufficient oxygen for flaming in the ceiling layer. In both cases, the gases can be well above the temperatures necessary to char or pyrolyze combustible finished materials in the hot layer.

5.5.4.2.5 Automatic sprinklers will normally operate early during this phase or even during the prior phase of burning. Quick-response sprinklers will operate much sooner than standard sprinklers. Detectors located outside the compartment may operate, depending on their location and the ability of smoke to travel from the fire to the point of the detector.

5.5.4.2.6 As the fire continues to grow, the ceiling layer gas temperatures approach 480°C (900°F), increasing the intensity of the radiation on the exposed combustible contents in the room. The surface temperature of these combustible contents rises, and pyrolysis gases are produced and become heated to their ignition temperature. When the upper layer temperature reaches approximately 590°C (1100°F), pyrolysis gases from the combustible contents ignite along with the bottom of the ceiling layer. This phenomenon, known as flashover, is illustrated in Figure 5.5.4.2.6. The terms *flameover* and *rollover* are often used to describe the condition where flames propagate through or across the ceiling layer only and do not involve the surfaces of target fuels. Flameover or rollover generally precede flashover but may not always result in flashover.

5.5.4.2.7 Postflashover burning conditions in a compartment are turbulent and dynamic. During postflashover burning, the position of the ceiling layer bottom and the existence and size of flaming on target fuels within the layer can vary between the conditions shown in Figure 5.5.4.2.6 and Figure 5.5.4.2.7. While the burning of floors or floor coverings is common, such burning may not always extend under target fuels or other shielding surfaces.

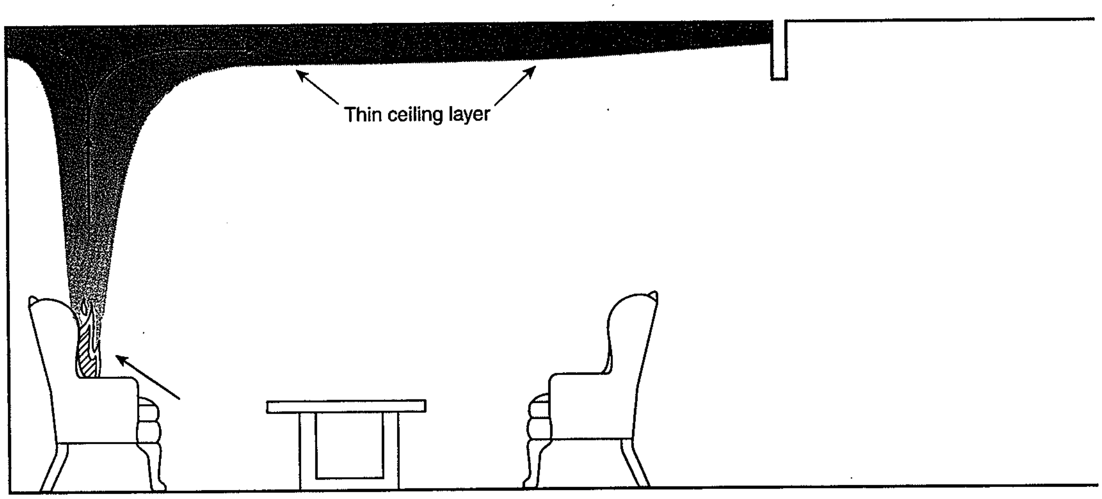

FIGURE 5.5.4.2 Early Compartment Fire Development.

of the object (i.e., vertical or horizontal spread), and wind direction (i.e., wind-aided or opposed flow spread). Combinations of these factors can either aid or hinder the rate at which flame will spread over an object. Flames may spread differently on different portions of the same fuel package, slowly across the horizontal surface of a chair cushion with spread increasing rapidly as the back of the chair becomes involved. If a material is able to melt when exposed to direct flame impingement or convective or radiative heating from an adjacent flame or hot products of combustion such as a hot upper layer in a room, it is likely to drip and pool on horizontal surfaces. The dripping of liquefied polyurethane foam from furniture can form a pool fire under that furniture. The ignition of the underside of the furniture by the pool fire increases the rate of burning of the furniture and is a good example of rapid flame spread. The melting and dripping of material can also result in the removal of fuel from the spreading flame front. This can significantly hinder the ability of the flame front to propagate across the surface of the material.

5.7.1.2 Flame spread over liquids can occur more rapidly than flame spread over solids. Flammable vapors are usually easier to form since the energy to volatilize the liquid is much less than the energy required to pyrolize a solid. Convective flows within the liquid ahead of the flame front help to heat the liquid and enhance the spread rate of flame over the surface of a pool. The temperature of the surface of the pool relative to the flash point temperature is a determining factor in the rate of flame spread over combustible liquids.

5.7.2 Fire Spread. Fire spread, as opposed to flame spread, involves the ignition of more remote fuel packages. The fuel packages can be located within the same or in adjacent compartments. The fire can spread either by direct flame impingement or remote ignition of adjacent fuel packages.

5.7.2.1 Fire Spread by Flame Impingement. As a fire grows, flame spread can be aided by the flow created by hot gases rising within the compartment. For example, the flames from a pool fire in the center of a compartment can be deflected by the flow of ambient air into the compartment through a doorway. The deflection of these flames from one fuel package can impinge on a second fuel package located adjacent to the first. In addition, due to lack of symmetry of airflow into a fire plume, flames from fuel packages located against a wall or in a corner can attach to vertical surfaces. If these surfaces are combustible, they can be ignited through direct flame contact.

5.7.2.2 Fire Spread by Remote Ignition. Remote ignition can occur through the three modes of heat transfer. A transfer of heat through conduction that results in ignition can occur through ceilings and walls. A common example would be the ignition of wood studs behind noncombustible masonry walls or partitions due to the heat from a compartment fire being conducted through the masonry to the combustible structural members.

5.7.2.2.1 Thermal radiant heat transfer that results in ignition can occur as hot smoke flows to adjacent compartments. The dominant method of spreading fire from one location to another remote location is through radiation. The hot smoke layer will transmit thermal radiation to other fuel packages, which may ignite. If the initial fire in a compartment grows large enough and involves enough fuel, the radiative output from the fire can become large enough to heat surfaces of other remote fuel packages up to the point when autoignition occurs and flame spread then begins on the remote fuel. This effect is observed at the point when a compartment transitions to flashover. Some of the factors that can affect this phenomenon are the size of the fire, the amount of energy radiated, the geometry between the two fuel objects (i.e., facing each other or at an angle one large object exposing a small object), and the distance between the two objects. *(See NFPA 555, Guide on Methods for Evaluating Potential for Room Flashover.)*

5.7.2.2.2 In addition to thermal radiant transfer from the hot layer, the investigator should be aware of "drop down" *(see 6.16.5.2)*. When a flame is burning an elevated structure or material within a compartment, the possibility exists that before the fuel is completely consumed, the structural elements will lose integrity and cause the fuel to fall to other areas within the compartment or on a lower level or floor of a building. If this occurs, the still burning fuel could be next to combustible material that has yet to ignite. The "drop down" fuel may provide enough conductive, convective, or radiant heat to ignite a lower fuel package, thus spreading fire.

5.7.3 Paths of Smoke Spread in Buildings. The flow of gases across an opening is the result of differences in pressure. Therefore, smoke can flow through doors, windows, and other opening within compartments. Since no compartment is hermetically sealed, there are leakage areas where smoke can flow between compartments. Plenum spaces above false ceilings are also a significant path for smoke travel. Smoke movement by temperature difference can result from the heat from the fire. In tall buildings smoke at a distance from the fire may be the same temperature as the ambient air but may be moving due to the building stack effect. Stack effect pressures result from differences between the temperatures inside and outside of the building. Pressure from HVAC systems can also transport smoke from one compartment to another.

Chapter 6 Fire Patterns

6.1 Introduction.

6.1.1 One of the major objectives of a fire scene examination is the recognition, identification, and analysis of fire patterns. The analysis of fire patterns is performed in an attempt to trace fire spread, identify areas and points of origin, and identify the fuels involved.

6.1.2 The circumstances of every fire are different from every other fire because of the differences in the structures, fuel loads, ignition factors, airflow, ventilation, and many other variable factors. This discussion, therefore, cannot cover every possible variation in fire patterns and how they come about. The basic principles are covered here, and the investigator should apply them to the particular fire incident under investigation.

6.2 Dynamics of Pattern Production.

6.2.1 General. The recognition, identification, and proper analysis of fire patterns by an investigator depends on an understanding of the dynamics of fire development and heat and flame spread. This recognition, identification, and proper analysis includes an understanding of the way that the three modes of heat transfer (conduction, convection, and radiation) produce the fire patterns and the nature of flame, heat, and smoke movement within a structure. *(See Chapter 5.)*

6.2.1.1 The damage created by flame, radiation, hot gases, and smoke creates patterns that investigators use to locate the area or point of fire origin.

6.2.5 Patterns Generated by Full Room Involvement. If a fire progresses to full room involvement *(see 5.5.4.2 through 5.5.4.2.11)*, damage found at low levels in the room down to and including the floor can be more extensive due to the effects of high radiative flux and the convected heat from the descending hot gas layer. Damage can include charring of the undersides of furniture, burning of carpet under furniture, uniform burning around table legs, burning of baseboards and the undersides of doors, and burning on floor covering in corners. Holes can be burned through carpet and floors. The effects of protected areas and floor clutter on low burn patterns should be considered *(see 6.17.7.2 and 6.18.2)*. Although the degree of damage will increase with time, the extreme conditions of the full room involvement can produce major damage in a few minutes, depending on ventilation and fuels present.

6.3 Fire Patterns Defined. Fire patterns are the visible or measurable physical effects that remain after a fire. These include thermal effects on materials, such as charring, oxidation, consumption of combustibles, smoke and soot deposits, distortion, melting, color changes, changes in the character of materials, structural collapse, and other effects.

6.3.1 Lines or Areas of Demarcation. Lines or areas of demarcation are the borders defining the differences in certain heat and smoke effects of the fire on various materials. They appear between the affected area and adjacent unaffected or less affected areas.

6.3.1.1 The production of lines and areas of demarcation, and the subsequent fire patterns that they define, depend on a combination of variables: the material itself, the rate of heat release of the fire, fire suppression activities, temperature of the heat source, ventilation, and the amount of time that the material is exposed to the heat.

6.3.1.2 For example, a particular material may display the same heat exposure patterns from exposure to a low-temperature heat source for a long period of time as to a high-temperature heat source for a shorter period of time. The investigator should keep this concept in mind while analyzing the nature of fire patterns.

6.3.2 Surface Effect. The nature and material of the surface that contains the fire pattern will have a bearing on the shape and nature of the pattern itself.

6.3.2.1 The shape and texture of the surface can affect the actual shape of the lines of demarcation displayed or increase or decrease the amount of pyrolysis and combustion by differing surface areas. If both a smooth and rough surface of the same material are exposed to the same source of heat, the rougher surface will sustain more damage. This effect is a result of the turbulence of the hot gases interacting with the surface as well as an increase in the surface-to-mass ratio. Differing surface coverings, such as paint, tiles, brick, wallpaper, plaster, and so forth, may increase or decrease the rate of heat degradation or burning.

6.3.2.2 Combustible surfaces will be darkened by the beginnings of pyrolysis, be burned, or be in various stages of charring, including the total loss of material. Noncombustible surfaces, such as mineral materials or metals, may exhibit color changes, oxidation, physical distortions, or melting.

6.3.3 Penetrations of Horizontal Surfaces. Penetration of horizontal surfaces, from above or below, can be caused by radiant heat, direct flame impingement, or localized smoldering with or without the effects of ventilation.

6.3.3.1 Penetrations in a downward direction are often considered unusual because the more natural direction of heat movement is upward through the action of buoyancy. In fully flashed-over compartments, however, hot gases may be forced through small, pre-existing openings in a floor, resulting in a penetration. Penetrations may also arise as the result of intense burning under furniture items such as polyurethane mattresses, couches, or chairs. Flaming or smoldering under collapsed floors or roofs can also lead to floor penetrations. Downward penetration, such as a hole burned into a floor or tabletop, should be noted and analyzed by the investigator.

6.3.3.2 Whether a hole burned into a horizontal surface was created from above or below may be identified by an examination of the sloping sides of the hole. Sides that slope downward from above toward the hole are indicators that the fire was from above. Sides that are wider at the bottom and slope upward toward the center of the hole indicate that the fire was from below. *(See Figure 6.3.3.2.)*

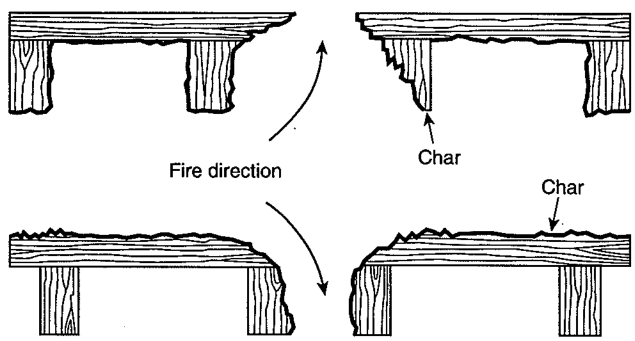

FIGURE 6.3.3.2 Burn Pattern with Fire from Above and Below.

6.3.3.3 Another reliable means of determining whether a fire moved up through or down through a surface is to compare the extent of destruction on the two levels separated by the surface. If fire moved up through the surface, the damage to the bottom side of the penetrated surface will be more extensive when compared to the top side. The converse is true where the fire moved downward.

6.3.3.4 It is, of course, possible for both upward and downward movement to occur through a hole during the course of a fire. The investigator should keep in mind that only the last movement through the hole may be evident.

6.3.4 Loss of Material. Typically, when wood or other combustible surfaces burn, they lose material and mass. The shapes and quantities of remaining combustibles can themselves produce lines of demarcation and, ultimately, fire patterns to be analyzed by the investigator. For example, the fact that the tops of wooden wall studs are burned away at progressively lower heights can be used in the "pointer and arrow" fire pattern analysis of fire spread.

6.3.5 Victim Injuries. The investigator should carefully note and document the position and condition of any fire victims and their relationship to other objects or victims. Autopsy reports and medical records may provide useful information regarding burn damage. For example, burn damage patterns and protected areas can be used in a similar way as damage to furniture and other items discussed in previous sections.

6.4 Types of Fire Patterns. There are two basic types of fire patterns: movement patterns and intensity patterns. These types of patterns are defined largely by the fire dynamics discussed in Section 5.5. Often a systematic use of more than one type of fire pattern at a fire scene can be used in combination to lead back to the heat source that produced them. Some patterns may display aspects defining both movement and intensity (heat/fuel).

6.4.1 Movement Patterns. Flame and heat movement patterns are produced by the growth and movement of fire and the products of combustion away from an initial heat source. If accurately identified and analyzed, these patterns can be traced back to the origin of the heat source that produced them.

6.4.2 Intensity (Heat) Patterns. Flame and heat intensity patterns are produced by the response of materials to the effects of various intensities of heat exposure. The various heat effects on a certain material can produce lines of demarcation. These lines of demarcation may be helpful to the investigator in determining the characteristics and quantities of fuel materials, as well as the direction of fire spread.

6.5 Surface Effect of Char. Many surfaces are decomposed in the heat of a fire. The binder in paint will char and darken the color of the painted surface. Wallpaper and the paper surface of gypsum wallboard will char when heated. Vinyl and other plastic surfaces on walls, floors, tables, or counters also will discolor, melt, or char. Wood surfaces will char, but, because of the greater significance of wood char, it is treated in greater detail in 6.5.1 through 6.5.5. The degree of discoloration and charring can be compared to adjacent areas to find the areas of greatest burning.

6.5.1 Wood Char. Charred wood is likely to be found in nearly all structural fires. When exposed to elevated temperatures, wood undergoes chemical decomposition that drives off gases, water vapor, and various pyrolysis products as smoke. The solid residue that remains is mainly carbon. Char shrinks as it forms, and develops cracks and blisters.

6.5.2* Rate of Charring. The depth of char measurements should not be relied on to determine the duration of the burning. The rule of 2.54 cm (1 in.) in 45 minutes for the rate of charring of pine is based on one set of laboratory conditions in a test furnace. Fires may burn with more or less intensity during the course of an uncontrolled fire than under a controlled laboratory fire. Actual laboratory char rates from exposure to heat from one side vary from 1 cm (0.4 in.) per hour at 390°C (750°F) to 25.4 cm (10 in.) per hour at temperatures approaching 1090°C (2000°F) in intense fires. Even these figures will vary with the species of the wood, orientation of the grain, moisture content, and other variables. Charring rate is also a function of the velocity of hot gases and the ventilation conditions. Fast-moving gases or ventilation can lead to rapid charring.

6.5.2.1 The rate of charring and burning of wood in general has no relation to its age once the wood has been dried. Wood tends to gain or lose moisture according to the ambient temperature and humidity. Thus, old dry wood is no more combustible than new kiln-dried wood if they have both been exposed to the same atmospheric conditions.

6.5.2.2 Overall, the use of the nature of char to make determinations about fuels involved in a fire should be done with careful consideration of all the possible variables that can affect the speed and severity of burning.

6.5.3 Depth of Char. Analysis of the depth of charring is most reliable for evaluating fire spread, rather than for the establishment of specific burn times or intensity of heat from adjacent burning materials. By measuring the relative depth and extent of charring, the investigator may be able to determine what portions of a material or construction were exposed the longest to a heat source. The relative depth of char from point to point is the key to appropriate use of charring — locating the places where the damage was most severe due to exposure, ventilation, or fuel placement. The investigator may then deduce the direction of fire spread, with decreasing char depths being farther away from the heat source.

6.5.3.1 Depth of Char Diagram. Lines of demarcation that may not be obvious can often be identified for analysis by a process of measuring and charting depths of char on a grid diagram. By drawing lines connecting points of equal char depth (isochars) on the grid diagram, lines of demarcation may be identified.

6.5.3.2 Depth of Char Analysis. Certain key variables affect the validity of depth of char pattern analysis. These factors include the following:

(1) Single versus multiple heat or fuel sources creating the char patterns being measured. Depth of char measurements may be useful in determining more than one fire or heat source.
(2) Comparison of char measurements, which should be done only for identical materials. It would not be valid to compare the depth of char from a wall stud to the depth of char of an adjacent wooden wall panel.
(3) Ventilation factors influencing the rate of burning. Wood can exhibit deeper charring when adjacent to a ventilation source or an opening where hot fire gases can escape.
(4) Consistency of measuring technique and method. Each comparable depth of char measurement should be made with the same tool and same technique. *[See Figure 15.4.2(f).]*

6.5.3.3 Measuring Depth of Char. Consistency in the method of measuring the depth of char is the key to accurate figures. Sharp pointed instruments, such as pocket knives, are not suitable for accurate measurements. The sharp end of the knife will have a tendency to cut into the noncharred wood beneath.

6.5.3.3.1 Thin, blunt-ended probes, such as certain types of calipers, tire tread depth gauges, or specifically modified metal rulers are best.

6.5.3.3.2 The same measuring tool should be used for any set of comparable measurements. Nearly equal pressure for each measurement while inserting the measuring device is also necessary for accurate results.

6.5.3.3.3 Char depth measurements, illustrated in Figure 6.5.3.3.3(a), should be made at the center of char blisters, rather than in or near the crevasses between blisters. Dial calipers with depth probes of round cross-section, shown in Figure 6.5.3.3.3(b), are excellent depth of char measurement tools. Figure 6.5.3.3.3(c) illustrates their use.

6.5.3.3.4 When determining the depth of charring, the investigator should take into consideration any burned wood that may have been completely destroyed by the fire and add that missing depth of wood to the overall depth measurement.

6.5.4 Depth of Char Patterns with Fuel Gases. When fugitive fuel gases are the initial fuel sources for fires, they produce relatively even depths of char over the often wide areas that they cover.

a fire, the presence of radiation from a hot gas layer will produce the same patterns. This pattern can also be caused by ignitable liquids. Analysis for their presence may be difficult due to the presence of hydrocarbons in tile adhesives.

6.16.2.4.7 Unburned areas present after a fire can reveal the location of content items that protected the floor or floor covering from radiation damage or smoke staining.

6.16.3 Outside Surfaces. External surfaces of structures can also display fire patterns. In addition to the regular patterns, both vertical and horizontal external surfaces can display burn-through. All other variables being equal, these burn-through areas can identify areas of intense or long-duration burning.

6.16.4 Building Contents. The sides and tops of building contents can form the bounding surfaces for fire patterns as well. Any patterns that can be produced on walls, ceilings, and floors can also be produced on the sides, tops, and undersides of chairs, tables, shelves, furniture, appliances, equipment, machinery, or any other contents. The patterns will be similar in shape but may only display portions of patterns because of their size.

6.16.5 Elevation. Patterns can also be used to determine the height at which burning may have begun within the structure.

6.16.5.1 Low Burn Patterns. It is common for the lowest portions of fire patterns to be closer to their heat sources. In general, fires tend to burn upward and outward from their origins. Fire plumes made up of the hot gases and airborne products of combustion are expanding and less dense than the surrounding air and are therefore buoyant. The growth in volume and buoyancy causes these heated products to rise and spread. The investigator should identify these areas of low burning and be cognizant of their possible proximity to a point of origin. The investigator should remember that in a compartment where the fire has transitioned through flashover to the fully developed stage, burning down to floor level is not necessarily indicative of an origin at the floor level.

6.16.5.2 Fall Down (Drop Down). The investigator should keep in mind that during the progress of a fire, burning debris often falls to lower levels and then burns upward from there. This occurrence is known as *fall down* or *drop down*. Fall down can ignite other combustible materials, producing low burn patterns that may be confused with the area of fire origin.

6.17* Pattern Geometry.

6.17.1 General.

6.17.1.1 Various patterns having distinctive geometry or shape are created by the effects of fire and smoke exposure on building materials and contents. In order to identify them for discussion and analysis, they have been described in the field by terms that are indicative of their shapes. While these terms generally do not relate to the manner in which the pattern was formed, the descriptive nature of the terminology makes the patterns easy to recognize. The discussion that follows will refer to patterns by their common names and provide some information about how they were formed and their interpretation. Additional information can be found in Section 6.2.

6.17.1.2 Since the interpretation of all possible fire patterns cannot be traced directly to scientific research, the user of this guide is cautioned that alternative interpretations of a given pattern are possible. In addition, patterns other than those described may be formed. Separate scientific research studies have begun to delve into the formation and interpretation of fire patterns. The two studies examined both pattern geometries and causal factors.

6.17.2 V Patterns on Vertical Surfaces. The appearance of the V-shaped pattern is created by flames, convective or radiated heat from hot fire gases, and smoke within the fire plume. *(See 6.2.2.)* The V pattern often appears as lines of demarcation (*see 6.3.1*) defining the borders of the fire plume and less heated areas outside the plume. An example is shown in Figure 6.17.2.

FIGURE 6.17.2 Typical V Pattern Showing Wall and Wood Stud Damage.

6.17.2.1 The angle of the V-shaped pattern is dependent on several variables *(see 6.2.2)*, including the following:

(1) The heat release rate (HRR) and geometry of the fuel
(2) The effects of ventilation
(3) The ignitability of the vertical surface on which the pattern appears and combustibility of the vertical surface on which it appears
(4) The presence of interceding horizontal surfaces such as ceilings, shelves, table tops, or the overhanging construction on the exterior of a building *(See 6.2.2.)*

6.17.2.2 The angle of the borders of the V pattern does not indicate the speed of fire growth; that is, a wide V does not indicate a slowly growing fire, or a narrow V does not indicate a rapidly growing fire.

6.17.3 Inverted Cone Patterns. Inverted cones are commonly caused by the vertical flame plumes of the burning volatile fuels not reaching the ceiling.

6.17.3.1 Interpretation of Inverted Cone Patterns. Inverted cone patterns are manifestations of relatively short-lived fires that do not fully evolve into floor-to-ceiling flame plumes or flame plumes that are not vertically restricted by ceilings. Because they often appear on noncombustible surfaces, they do not always readily spread to nearby combustibles. For this reason, many investigators have taken to inferring from these patterns that the fires that caused them were fast burning.

6.17.6.1 The cone-shaped dispersion of heat is caused by the natural expansion of the fire plume as it rises and the horizontal spread of heat energy when the fire plume encounters an obstruction to its vertical movement, such as the ceiling of a room. Thermal damage to a ceiling will generally extend beyond the circular area attributed to a "truncated cone." The truncated cone pattern combines two-dimensional patterns such as V-shaped patterns, pointers and arrows, and U-shaped patterns on vertical surfaces, with the circular patterns displayed on ceilings and other horizontal surfaces.

6.17.6.2 The combination of more than one two-dimensional pattern on perpendicular vertical and horizontal surfaces gives the truncated cone pattern its three-dimensional character.

6.17.6.3 A theoretical demonstration of the truncated cone pattern is when the four vertical walls of a room each display varied V or U patterns, as well as circular or portions of circular patterns appearing on the ceiling. Corresponding patterns may also be discernible on the furnishings in the room.

6.17.7 Pointer and Arrow Patterns. These fire patterns are commonly displayed on a series of combustible elements such as wooden studs or furring strips of walls whose surface sheathing has been destroyed by fire or was nonexistent. The progress and direction of fire spread along a wall can often be identified and traced back toward its source by an examination of the relative heights and burned-away shapes of the wall studs left standing after a fire. In general, shorter and more severely charred studs will be closer to a source of fire than taller studs. The heights of the remaining studs increase as distance from a source of fire increases. The difference in height and severity of charring will be noted on the studs, as shown in Figure 6.17.7.

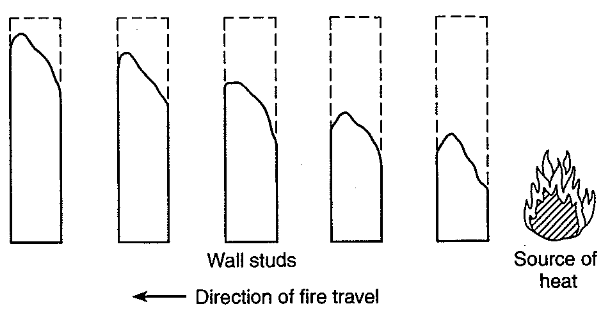

FIGURE 6.17.7 Wood Wall Studs Showing Decreasing Damage as Distance from Fire Increases.

6.17.7.1 The shape of the studs' cross section will tend to produce "arrows" pointing back toward the general area of the source of heat. This is caused by the burning off of the sharp angles of the edges of the studs on the sides toward the heat source that produces them, as shown in Figure 6.17.7.1.

6.17.7.2 More severe charring can be expected on the side of the stud closest to the heat source.

6.17.8 Circular-Shaped Patterns. Patterns that are generally circular in shape are common at fire scenes. These patterns are never truly circular unless they represent areas that have been protected from burning by circular items, such as wastebaskets or the bottoms of furniture items.

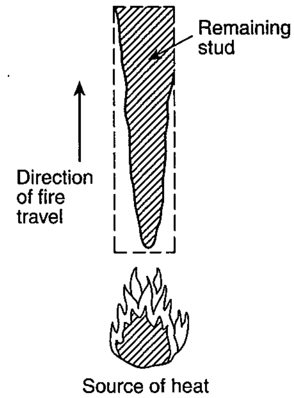

FIGURE 6.17.7.1 Cross Section of Wood Wall Stud Pointing Toward Fire.

6.17.8.1 Bottoms of Horizontal Surfaces. Patterns on the underside of horizontal surfaces, such as ceilings, tabletops, and shelves, can appear in roughly circular shapes. The more centralized the heat source, the more circular or nearly circular the patterns may appear.

6.17.8.1.1 Portions of circular patterns can appear on the underside of surfaces that partially block the heated gases or fire plumes. This appearance can occur when the edge of the surface receiving the pattern does not extend far enough to show the entire circular pattern or when the edge of the surface is adjacent to a wall.

6.17.8.1.2 Within the circular pattern, the center may show more heat degradation, such as deeper charring. By locating the center of the circular pattern, the investigator may find a valuable clue to the source of greatest heating, immediately below.

6.17.8.2 Irregular Patterns. Irregular, curved, or "pool-shaped" patterns on floors and floor coverings should not be identified as resulting from ignitable liquids on the basis of observation of the shape alone. In cases of full room involvement, patterns similar in appearance to ignitable liquid burn patterns can be produced when no ignitable liquid is present.

6.17.8.2.1 The lines of demarcation between the damaged and undamaged areas of irregular patterns range from sharp edges to smooth gradations depending on the properties of the material and the intensity of heat exposure. Denser materials like oak flooring will generally show sharper lines of demarcation than thermoplastic (e.g., nylon) carpet. The absence of a carpet pad often leads to sharper lines.

6.17.8.2.2 These patterns are common in situations of post-flashover conditions, long extinguishing times, or building collapse. These patterns may result from the effects of hot gases, flaming and smoldering debris, melted plastics, or ignitable liquids. If the presence of ignitable liquids is suspected, supporting evidence such as the use of a combustible gas indicator, chemical analysis of debris for residues, or the presence of liquid containers should be sought. It should be noted that many plastic materials release hydrocarbon fumes when they pyrolize or burn. These fumes may have an odor similar to that of petroleum products and can be detected by combustible gas indicators when no ignitable liquid accelerant has been used. A "positive" reading should prompt further investigation

FIGURE 6.17.11 Saddle Burn in a Floor Joist.

FIGURE 6.18.1 Trailer Running Up a Stairway.

6.18.2 Protected Floor Areas. Often when the floor area is cleared of debris to examine damage, long, wide, straight patterns will be found, showing areas of extensive heat damage bounded on each side by undamaged or less damaged areas. These patterns often have been interpreted to be "trailers." While this is possible, the presence of furniture, stock, counters, or storage may result in these linear patterns. These patterns may also result from wear on floors and the floor covering due to high traffic. Irregularly shaped objects on the floor, such as clothing or bedding, may also provide protection and produce patterns that may be inaccurately interpreted.

6.18.3 Fuel Gas Jets. Jets of ignited fuel gases, such as LP-Gas or natural gas, can produce linear patterns or lines of demarcation, particularly on noncombustible surfaces.

6.19 Area Patterns. Some patterns may appear to cover entire rooms or large areas without any readily identifiable sources or beginnings. These patterns are most often formed when the fuels that create them are widely dispersed before ignition, or when the movement of the fire through the areas is very rapid, as in a flash fire.

6.19.1 Flashover and Full Room Involvement. In the course of a flashover transition, fire spreads rapidly to all exposed combustible materials as the fire progresses to full room involvement. *(See 5.5.4.2.)* This process can produce relatively uniform depths of char or calcination on vertical surfaces. If the fire is terminated before full room involvement, relatively uniform burning can be evident on vertical surfaces above the bottom of the hot layer. When the fire has progressed to full room involvement, the area pattern may be uneven and may extend to the base of the wall. The uniformity described in this section may not be consistent throughout the room or space. Some exposed surfaces may have little or no damage due to the ventilation effects or the locations of furnishings or fixtures that may prevent charring, darkening or discoloration of wall and ceiling surfaces.

6.19.2 Flash Fires. The ignition of gases or the vapors of liquids does not necessarily always cause explosions. Whether or not an explosion occurs depends on the location and concentration of diffuse fuels and on the geometry, venting, and strength of the confining structure. *(See Section 21.1.)*

6.19.2.1 If the diffuse fuels are near the lower flammable or explosive limit (LEL) and there is no explosion, the fuels may burn as a flash fire, and there may be little or no subsequent burning. In the instance where the first fuel to be ignited is a diffuse fuel–air mixture, the area of greatest destruction may not, and generally does not, coincide with the area where the heat source ignites the mixture. The greatest destruction will occur where the flash fire from the burning mixture encounters a secondary fuel load that is capable of being ignited by the momentary intense temperature in the flame front. Likewise, once secondary ignition occurs, the dynamics of the fire spread will be dictated by the compartment and fuel geometry and the relative heat release rates of these secondary fuels. The relatively short duration of the burning mixture may have little impact on the flashover in the compartment as compared to the burning of the secondary fuels. Therefore, origin determination of such a flash fire is dependent on accurate witness observations and the analysis of the potential ignition sources in the areas where the vapor or gas could have existed.

6.19.2.2 Without accurate witness statements and careful analysis of potential ignition sources, the investigator is left with the analysis of fire patterns as the only means of determining the origin. The difficulty of this task is that the resultant ignition of the secondary fuels and compartment flashover can camouflage the subtle patterns created by the flash fire.

6.19.2.3 This difficulty is caused by the total consumption of the available fuel without significantly raising the temperatures of other combustibles. In this case, the fire patterns may be superficial and difficult to trace to any specific point of ignition as in Figure 6.19.2.3. In addition, separate areas of burning from pocket fuel gas may exist and further confuse the tracing of fire spread.

6.19.3 Patterns Generated by Suppression. Hose streams are capable of altering the spread of the fire and creating fire damage in places where the fire would not move in the absence of the hose stream. Additionally, some fire departments

7.2.4 Occupancy. When considering how the building elements affected the way in which a fire developed and spread, the investigator should consider whether the occupancy was acceptable for the design and condition of the building. A change in the occupancy of a building can produce much greater fire loads, ventilation effects, total heats of combustion, and heat release rates than originally expected. For example, a warehouse that was originally designed to store automotive engine parts will have a totally different reaction to a fire if the occupancy is changed to the high-rack storage of large quantities of ignitable liquids. The original design may have been adequate for the first fuel load, but inadequate for the subsequent fuel load with its increased hazard.

7.2.5 Computer Fire Model Survey of Building Component Variations. In analyzing the effects of building design upon the development, spread, and ultimate damage from a fire, the use of computer fire models can be very helpful. Through the use of models, the investigator can view the various effects of a number of design variables. By modeling differing building design components, the investigator can see how the changes in a component can change the computed development and growth of the fire.

7.2.6 Explosion Damage.

7.2.6.1 The amount and nature of damage to a building from an explosion is also affected by the design of the structure. The stronger the construction of the exterior or interior confining walls, the more a building can withstand the effects of a low-pressure or slow rate-of-pressure-rise explosion. Conversely, the more brisant or demolishing damage will result from a high-pressure or rapid rate-of-pressure-rise explosion. The shape of the explosion-confining room can also have an effect on the resulting damage. *(See 21.8.2.4, 21.8.2.6, and 21.13.3.1 on explosions for more information.)*

7.2.6.2 In a low order explosion, the more windows, doors, or other available vents within the confining structure, the less structural damage will be sustained.

7.3 Types of Construction.

7.3.1 General.

7.3.1.1 The following discussion concerning the types of construction is based on the methods of construction and materials rather than the descriptions used in classification systems of the model building codes. When necessary, the fire investigator should obtain the building construction classifications and descriptions that are a part of the particular building code that is enforced in the jurisdiction in which the fire occurred and should use them as a part of the scene documentation. For further detail, the investigator is directed to the NFPA *Fire Protection Handbook.*

7.3.1.2 The investigator should document the types of construction by looking at the main structural elements. Documentation may include main structural components, breaches, structural changes, or other factors that may influence structural integrity or fire spread.

7.3.2 Wood Frame. Wood frame construction is often associated with residential construction and contemporary lightweight commercial construction. Buildings with wood structural members and a masonry veneer exterior are considered wood frame. Lightweight wood frame construction is usually used in buildings of limited size. Floor joists in such construction are normally spaced 16 in. on center, and the vertical supports are often nominal two by four or nominal two by six wall-bearing studs, again spaced 16 in. on center. Wood frame construction has little fire resistance because flames and hot gases can penetrate into the spaces between the joists or the studs, allowing fire spread outside of the area of origin. *(See 6.16.1.3)* Wood frame construction is classified as Type V construction, as defined in NFPA 220, *Standard on Types of Building Construction.* Wood frame construction can be sheathed with a fire-resistive membrane (e.g., gypsum board, lath and plaster, mineral tiles) to provide up to 2-hour fire resistance when tested in accordance with ASTM E 119, *Standard Methods of Tests of Fire Endurance of Building Construction and Materials.* Such high fire resistances in frame construction are unusual but may be encountered in special occupancies such as one- or two-story nursing homes.

7.3.2.1 Platform Frame Construction.

7.3.2.1.1 Platform frame construction is the most common construction method currently used for residential and lightweight commercial construction. In this method of construction, separate platforms or floors are developed as the structure is built. The foundation wall is built; joists are placed on the foundation wall; then a subfloor is placed. The walls for the first floor are then constructed, with the ceiling joists placed on the walls. The rafter, ridgepole, or truss construction methods are used for the roof assembly. An important fire concern other than the fact that combustible materials are used in construction is that there are concealed spaces in soffits and other areas for fire to spread without detection.

7.3.2.1.2 Platform construction inherently provides fire barriers to vertical fire travel as a result of the configuration of the stud channels. However, these barriers in wood frame construction are combustible and may be breached over the course of the fire allowing the fire to spread to other spaces. Vertical fire spread may also occur in platform construction through utility paths, such as electrical, plumbing, and HVAC. Openings for utilities in wall stud spaces may allow easy passage of the fire from floor to floor.

7.3.2.2 Balloon Frame.

7.3.2.2.1 In this type of construction, the studs go from the foundation wall to the roofline. The floor joists are attached to the walls by the use of a ribbon board, which creates an open stud channel between floors, including the basement and attic. This type of construction is typical in many homes built prior to 1940.

7.3.2.2.2 Almost all building codes have for many years required fire stopping of all vertical channels in balloon frame construction. Where fire stopping is present, buildings of balloon frame construction respond to fire similarly to buildings of platform frame construction. Fire stopping can be in the form of wood boards or by filling of the void space with noncombustible materials, historically with brick or dirt, and more recently with insulation. Where such fire stops were not installed or later removed (typically to install a utility such as wiring, HVAC, or other services), balloon frame construction provides unobstructed vertical channels, in concealed spaces behind interior finish, for rapid undetected vertical fire spread. Rapid fire spread and horizontal extension is further enhanced by the open connections of the floor joists to the vertical channels. Fire can spread upward to other floors or attic spaces and horizontally through floor spaces. Balloon frame construction will also allow fall down from above to ignite lower levels. Fire originating on lower levels can extend

7.4.3.3 A fire barrier wall is a wall, other than a fire wall, having a fire resistance rating. Fire walls and fire barrier walls do not need to meet the same requirements as smoke barriers.

7.4.3.4 Smoke barriers are continuous membranes, either vertical or horizontal, such as a wall, floor, or ceiling assembly, designed and constructed to restrict the movement of smoke. A smoke barrier might or might not have a fire resistance rating. Such barriers might have protected openings.

7.4.3.5 Penetrations are regularly found in wall assemblies. The penetrations often are used to provide access for doors, utilities, HVAC systems, plumbing, computer data and communication, and other functions. Penetrations in fire-rated wall assemblies are required to be sealed to maintain the rating. Unsealed penetrations facilitate the passage of fire and smoke through the wall assembly, allowing the fire to spread horizontally.

7.4.3.6 A fire barrier wall is not required to be constructed of noncombustible materials. Fire barrier walls constructed of combustible materials include the use of wood studs with type X gypsum board on the exterior surfaces. Where the structure has a load-bearing party wall assembly, combustible materials can again be used. In this instance, there are two separate stud walls built; the exterior finish is gypsum board; between the two stud walls plywood is attached; and there is an air space between the walls. Most requirements for a fire barrier wall will have type X on both sides of the wall to make it fire resistive.

7.4.3.7 There are a number of other walls found in structures. While these walls have not been subjected to fire tests in order to be rated, they will still provide some resistance to the spread of fire within a building.

7.4.4 Doors. Doors may be a key factor in the spread of fire. Doors can be made of a variety of materials and be fire rated or non–fire rated. It should be noted that if there is a door opening in a fire-rated wall or partition, it would be required to be provided with an appropriate fire-rated door, installed as an entire assembly. Fire-rated door assemblies are required to include rated frames, hinges, closures, latching devices, and if provided (and allowed), glazing. Fire doors may be of wood, steel, or steel with an insulated core of wood or mineral material. While some doors have negligible insulating value, others may have a heat transmission rating of 121°C, 232°C, and 343°C (250°F, 450°F, and 650°F). This means the doors will limit temperature rise on the unexposed side to that respective value when exposed to the standard time–temperature for 30 minutes. This insulating value aids egress, particularly in stairwells in multistory buildings, and provides some protection against autoignition of combustibles near the opening's unexposed side. In addition to the rating of the door, to be effective in limiting the spread of fire from one compartment to another, the door must be closed. The position of doors can change during and after a fire for a variety of reasons, including automatic closure systems, personnel movement, and fire suppression activities.

7.4.5 Concealed Spaces. Spaces that are generally inaccessible or limited access areas of a structure such as interstitial space above a ceiling, below a floor, or between walls. Attics, accessible or not, may also be considered a concealed space. Concealed spaces provide a hidden path for fire to grow or spread without being identified early in the event. By the time fire moves out of the concealed space, it often has already spread extensively throughout the structure. Fires in concealed spaces are difficult to extinguish. Concealed spaces are found in almost all types of construction and may have built-in fire protection features such as sprinklers, barriers, and automatic detection. The presence, performance, or absence of these protective features may have a dramatic effect on progression of the fire. For those concealed spaces identified as noncombustible, all components, materials, or equipment used in the construction of the concealed space must be of noncombustible or fire-resistive assemblies, or must have been provided with listed fire-protective coating. Concealed spaces normally classified as noncombustible may still contain some combustible materials such as fire-retardant-treated lumber, communications and power wiring cable, and plastic pipe. Fires can still start and spread in concealed spaces that are classified as noncombustible.

Chapter 8 Electricity and Fire

8.1 Introduction. This chapter discusses the analysis of electrical systems and equipment. The primary emphasis is on buildings with 120/240-volt, single-phase electrical systems. These voltages are typical in residential and commercial buildings. This chapter also discusses the basic principles of physics that relate to electricity and fire.

8.1.1 Prior to beginning an analysis of a specific electrical item, it is assumed that the person responsible for determining the cause of the fire will have already defined the area or point of origin. Electrical equipment should be considered as an ignition source equally with all other possible sources and not as either a first or last choice. The presence of electrical wiring or equipment at or near the origin of a fire does not necessarily mean that the fire was caused by electrical energy. Often the fire may destroy insulation or cause changes in the appearance of conductors or equipment that can lead to false assumptions. Careful evaluation is warranted.

8.1.2 Electrical conductors and equipment that are used appropriately and protected by properly sized and operating fuses or circuit breakers do not normally present a fire hazard. However, the conductors and equipment can provide ignition sources if easily ignitable materials are present where they have been improperly installed or used. A condition in the electrical wiring that does not conform to the NFPA 70, *National Electrical Code*, might or might not be related to the cause of a fire.

8.2 Basic Electricity.

8.2.1 General. The purpose of this section is to present basic electrical terms and concepts briefly and simply in order to develop a working understanding of them.

8.2.2 Comparing Electricity to Hydraulics. Water flowing through a pipe is familiar to everyone. This phenomenon has some similarities to electrical current flowing in an electrical system. Because of these similarities, a limited comparison between a hydraulic system and an electrical system can be used to understand an electrical system.

8.2.2.1 Elements of Hydraulic and Electrical Systems. Table 8.2.2.1(a) compares selected hydraulic system hardware with analogous electrical system hardware. Table 8.2.2.1(b) compares selected hydraulic quantities and hydraulic units with analogous electrical quantities and electrical units.

12.2.7.2 In addition, it is not uncommon for atmospheres with insufficient oxygen to be present within a structure that has been exposed to fire or explosion. Fire scene atmospheres may contain ignitable gas, vapors, and liquids. The atmosphere should be tested using appropriate equipment to determine whether such hazards or conditions exist before working in or introducing ignition sources into the area. Such ignition sources may include electrical arcs from flashlights, radios, cameras and their flashes, and smoking materials.

12.3 Criminal Acts or Acts of Terrorism. Fire is an event that can result from a criminal act. The initial incendiary device that created the fire or explosion may not be the only device left at the scene by the perpetrator. A secondary incendiary or explosive device may be left at the scene with the intent to harm fire, rescue, or investigative personnel. Of further concern are the chemicals used in the device that may leave a residue, creating an additional exposure.

12.3.1 Secondary Devices. The potential endangerment from a secondary incendiary or explosive device is remote compared to other hazards created at the scene from the initial device. However, the investigator should always be wary of any unusual packages or containers at the crime scene. If there is reason to believe that such a device may exist, it is necessary to contact the appropriate authorities to have specialists "sweep" the area. Close cooperation between investigative personnel and the explosive ordnance disposal (EOD) specialists can preclude the unnecessary destruction of the crime scene.

12.3.2 Residue Chemicals. If the incendiary or explosive device is rendered safe by the appropriate personnel, care should be taken when handling the rendered device or any residue from the device. Exposure to the chemical residue could endanger the investigator. Appropriate protective clothing and breathing apparatus should be worn while in the process of collecting such evidence.

12.3.3 Biological and Radiological Terrorism. There is a potential for a terrorist to release biological or radiological particulates as a part of his or her terrorist act. Usually the emergency response personnel will be aware of such an act while mitigating the emergency incident. If there is any suspicion that either type of hazardous substance has been released, the scene must be rendered safe prior to the entry of investigative personnel. If this rendering is not possible and the investigation is to go forward, only those investigative personnel trained to work in such atmospheres should be allowed to enter the scene.

12.3.4 Exposure to Tools and Equipment. Many of the tools and equipment used in the process of conducting an investigation may be rendered unsafe after being used in hazardous atmospheres. The necessary procedures, equipment, tools, and supplies to render your equipment safe should be in place prior to undertaking the investigation. Precautions should also be in place to dispose of the tools safely should they be incapable of being rendered safe.

12.4 Safety in Off-Scene Investigation Activities.

12.4.1 Safety considerations also extend to ancillary fire investigation activities not directly related to the fire or explosion scene examination. Such ancillary investigation activities include physical evidence handling and storage, laboratory examinations and testing, live fire or explosion recreations and demonstrations. The basic safety precautions dealing with use of safety clothing and equipment, the proper storage and prominent labeling of hazardous materials evidence, thermal, inhalation, electrical dangers of fire and explosion recreations or demonstrations should be followed.

12.4.2 Valuable safety information may be found in NFPA 30, *Flammable and Combustible Liquids Code,* NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* NFPA 471, *Recommended Practice for Responding to Hazardous Materials Incidents,* NFPA 1403, *Standard on Live Fire Training Evolutions,* and NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.* Additional information may also be obtained by the appropriate government agency regulations such as Occupational Safety and Health Administration (OSHA) documents, Environmental Protection Agency (EPA) documents, state and local regulations, and documents written by other standards-making organizations such as the Compressed Gas Association (CGA), American Petroleum Institute (API), American Society of Testing and Materials (ASTM), American National Standards Institute (ANSI), and others that may impact the investigation activities.

Chapter 13 Sources of Information

13.1* General.

13.1.1 Purpose of Obtaining Information. The thorough fire investigation always involves the examination of the fire scene, either by visiting the actual scene or by evaluating the prior documentation of that scene.

13.1.1.1 By necessity, the thorough fire investigation also encompasses interviewing and the research and analysis of other sources of information. These activities are not a substitute for the fire scene examination. They are a complement to it.

13.1.1.2 Examining the fire scene, interviewing, and conducting research and analysis of other sources of information all provide the fire investigator with an opportunity to establish the origin, cause, and responsibility for a particular fire.

13.1.2 Reliability of Information Obtained.

13.1.2.1 Generally, any information solicited or received by the fire investigator during a fire investigation is only as reliable as the source of that information. As such, it is essential that the fire investigator evaluate the accuracy of the information's source. Certainly, no information should be considered to be accurate or reliable without such an evaluation of its source.

13.1.2.2 This evaluation may be based on many varying factors depending on the type and form of information. These factors may include the fire investigator's common sense, the fire investigator's personal knowledge and experience, the information source's reputation, or the source's particular interest in the results of the fire investigation.

13.2 Legal Considerations.

13.2.1 Freedom of Information Act.

13.2.1.1 The Freedom of Information Act provides for making information held by federal agencies available to the public unless it is specifically exempted from such disclosure by law. Most agencies of the federal government have implemented procedures designed to comply with the provisions of the act. These procedures inform the public where specific sources of information are available and what appeal rights are available to the public if requested information is not disclosed.

13.2.1.2 Like the federal government, most states have also enacted similar laws that provide the public with the opportunity to access sources of information concerning government operations and their work products. The fire investigator is cautioned, however, that the provisions of such state laws may vary greatly from state to state.

13.2.2 Privileged Communications.

13.2.2.1 Privileged communications are those statements made by certain persons within a protected relationship such as husband-wife, attorney-client, priest-penitent, and the like. Such communications are protected by law from forced disclosure on the witness stand at the option of the witness spouse, client, or penitent.

13.2.2.2 Privileged communications are generally defined by state law. As such, the fire investigator is cautioned that the provisions of such laws may vary greatly from state to state.

13.2.3 Confidential Communications. Closely related to privileged communications, confidential communications are those statements made under circumstances showing that the speaker intended the statements only for the ears of the person addressed.

13.3 Forms of Information. Sources of information will present themselves in differing forms. Generally, information is available to the fire investigator in four forms: verbal, written, visual, and electronic.

13.3.1 Verbal Information. Verbal sources of information, by definition, are limited to the spoken word. Such sources, which may be encountered by the fire investigator, may include, but are not limited to, verbal statements during interviews, telephone conversations, tape recordings, radio transmissions, commercial radio broadcasts, and the like.

13.3.2 Written Information. Written sources of information are likely to be encountered by the fire investigator during all stages of an investigation. Such sources may include, but are not limited to, written reports, written documents, reference materials, newspapers, and the like.

13.3.3 Visual Information. Visual sources of information, by definition, are limited to those that are gathered utilizing the sense of sight. Beginning first with the advent of still photography, such sources may include, but are not limited to, photographs, videotapes, motion pictures, and computer-generated animations.

13.3.4 Electronic Information. Computers have become an integral part of modern information and data systems. As such, the computer system maintained by any particular source of information may provide a wealth of information relevant to the fire investigation.

13.4 Interviews.

13.4.1 Purpose of Interviews. The purpose of any interview is to gather both useful and accurate information. Witnesses can provide such information about the fire and explosion incident even if they were not eyewitnesses to the incident.

13.4.1.1 The investigator should make every effort to identify the ignition sequence factors as soon as possible. These questions should address those issues covered in Section 18.3, Section 18.4, and Section 18.5.

13.4.1.2 It is the responsibility of the investigator to evaluate the quality of the data obtained from the witness at the time of the interview.

13.4.2 Preparation for the Interview. The fire investigator should be thoroughly prepared prior to conducting any type of interview, especially if the investigator intends to solicit relevant and useful information. The most important aspect of this preparation is a thorough understanding of all facets of the investigation.

13.4.2.1 The fire investigator should also carefully plan the setting of the interview, that is, when and where the interview will be held. Although the time that the interview is conducted may be determined by a variety of factors, the interview should generally be conducted as soon as possible after the fire or explosion incident.

13.4.2.2 It may be helpful to the investigator to conduct preliminary interviews before the fire scene examination commences, although there are many instances when this may be impractical.

13.4.2.3 The interviewer and the person being interviewed should be properly identified. The interview should, therefore, begin with the proper identification of the person conducting the interview. The date, time, and location of the interview, as well as any witnesses to it, should be documented.

13.4.2.4 The person being interviewed should also be completely and positively identified. Positive identification may include the person's full name, date of birth, Social Security number, driver's license number, physical description, home address, home telephone number, place of employment, business address, business telephone number, or other information that may be deemed pertinent to establish positive identification.

13.4.2.5 Lastly, the fire investigator should also establish a flexible plan or outline for the interview.

13.4.3 Documenting the Interview. All interviews, regardless of their type, should be documented. Tape recording the interview or taking written notes during the interview are two of the most common methods of documenting the interview. Both of these methods, however, often tend to distract or annoy the person being interviewed, resulting in some information not being solicited from them. An alternative method used to document interviews can be accomplished through the use of visual taping. All taping must be done in accordance with applicable laws and regulations. The investigator should obtain signed written statements from as many witnesses as possible to enhance their admissibility in court.

13.5 Governmental Sources of Information.

13.5.1 Municipal Government.

13.5.1.1 Municipal Clerk. The municipal clerk maintains public records regarding municipal licensing and general municipal business.

13.5.1.2 Municipal Assessor. The municipal assessor maintains public records regarding plats or maps of real property, including dimensions, addresses, owners, and taxable value of the real property and any improvements.

13.5.1.3 Municipal Treasurer. The municipal treasurer maintains public records regarding names and addresses of property owners, names and addresses of taxpayers, legal descriptions of property, amount of taxes paid or owed on real and personal property, and former owners of the property.

13.5.1.4 Municipal Street Department. The municipal street department maintains public records regarding maps of the

Chapter 16 Physical Evidence

16.1* General. During the course of any fire investigation, the fire investigator is likely to be responsible for locating, collecting, identifying, storing, examining, and arranging for testing of physical evidence. The fire investigator should be thoroughly familiar with the recommended and accepted methods of processing such physical evidence.

16.2 Physical Evidence.

16.2.1 Physical evidence, defined generally, is any physical or tangible item that tends to prove or disprove a particular fact or issue. Physical evidence at the fire scene may be relevant to the issues of the origin, cause, spread, or the responsibility for the fire.

16.2.2 The decision on what physical evidence to collect at the incident scene for submission to a laboratory or other testing facility for examination and testing, or for support of a fact or opinion, rests with the fire investigator. This decision may be based on a variety of considerations, such as the scope of the investigation, legal requirements, or prohibition. *(See Section 13.2.)* Additional evidence may also be collected by others, including other investigators, insurance company representatives, manufacturer's representatives, owners, and occupants. The investigator should also be aware of issues related to spoliation of evidence.

16.3* Preservation of the Fire Scene and Physical Evidence.

16.3.1 General. Every attempt should be made to protect and preserve the fire scene as intact and undisturbed as possible, with the structure, contents, fixtures, and furnishings remaining in their pre-fire locations. Evidence such as the small paper match shown in Figure 16.3.1 could easily be destroyed or lost in an improperly preserved fire scene.

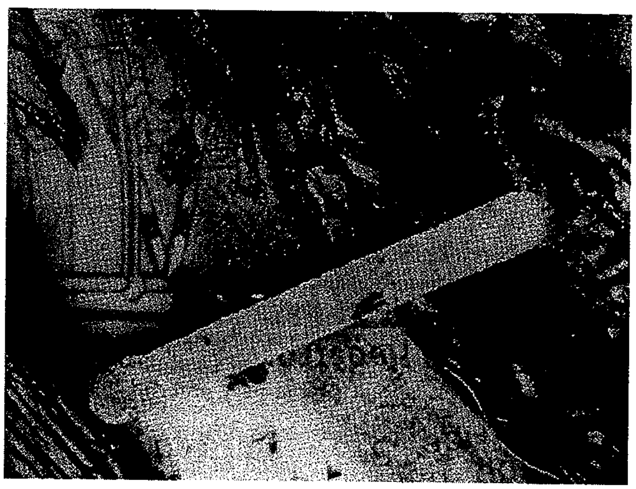

FIGURE 16.3.1 Physical Evidence at a Fire Scene.

16.3.1.1 Generally, the cause of a fire or explosion is not known until near the end of the investigation. Therefore, the evidentiary or interpretative value of various pieces of physical evidence observed at the scene may not be known until, at, or near the end of the fire scene examination, or until the end of the complete investigation. As a result, the entire fire scene should be considered physical evidence and should be protected and preserved. Consideration should be given to temporarily placing removed ash and debris into bags, tarps, or other suitable containers labeled as to the location from which it was removed. This way, if components from an appliance or an incendiary device are found to be missing they can be more easily found in a labeled container.

16.3.1.2 The responsibility for the preservation of the fire scene and physical evidence does not lie solely with the fire investigator, but should begin with arriving fire-fighting units or police authorities. Lack of preservation may result in the destruction, contamination, loss, or unnecessary movement of physical evidence. Initially, the incident commander and, later, the fire investigator should secure or ensure the security of the fire scene from unnecessary and unauthorized intrusions and should limit fire suppression activities to those that are necessary.

16.3.1.3 Evidence at the fire scene should be considered not only in a criminal context, such as in traditional forensic evidence (e.g., weapons, bodily fluids, footprints), nor should it be limited to arson-related evidence, items, or artifacts, such as incendiary devices or containers. Potential evidence at the fire scene and surrounding areas can include the physical structure, the contents, the artifacts, and any materials ignited or any material on which fire patterns appear.

16.3.2 Fire Patterns as Physical Evidence. The evidentiary and interpretative use of fire patterns may be valuable in the identification of a potential ignition source, such as an incendiary device in an arson fire or an appliance in an accidental fire. Fire patterns are the visible or measurable physical effects that remain after a fire. These include thermal effects on materials, such as charring, oxidation, consumption of combustibles, smoke and soot deposits, distortion, melting, color changes, changes in the character of materials, structural collapse, and other effects. *(See Section 6.3.)*

16.3.3 Artifact Evidence. Artifacts can be the remains of the material first ignited, the ignition source, or other items or components in some way related to the fire ignition, development, or spread. An artifact may also be an item on which fire patterns are present, in which case the preservation of the artifact is not for the item itself but for the fire pattern that is contained thereon.

16.3.4 Protecting Evidence.

16.3.4.1 There are a number of methods that can be utilized to protect evidence from destruction. Some methods include posting a fire fighter or police officer as a sentry to prevent or limit access to a building, a room, or an area; use of traffic cones or numerical markers to identify evidence or areas that warrant further examination; covering the area or evidence with tarpaulins prior to overhaul; or isolating the room or area with rope, caution tape, or police line tape. The investigator may benefit from supervising overhaul and salvage operations.

16.3.4.2 Items found at the fire scene, such as empty boxes or buckets, may be placed over an artifact. However, these items may not clearly identify the artifact as evidence that should be preserved by fire fighters or others at the fire scene. If evidence is not clearly identified, it may be susceptible to movement or destruction at the scene.

16.3.5 Role and Responsibilities of Fire Suppression Personnel in Preserving the Fire Scene.

16.3.5.1 Generally, fire officers and fire fighters have been instructed during basic fire training that they have a responsibility on the fire scene regarding fire investigation.

bench-scale laboratory instrument for measuring heat release rate, radiant ignitability, smoke production, mass loss rate, and certain toxic gases of materials.

16.10.2.27 Ignition Properties of Plastics (ASTM D 1929). This test method, from ASTM D 1929, *Standard Test Method for Determining Ignition Temperature of Plastics*, covers a laboratory determination of the self-ignition and flash-ignition temperatures of plastics using a hot-air ignition furnace.

16.10.2.28 Dielectric Withstand Voltage (Mil-Std–202F Method 301). This test method, from Mil-Std–202F, *Test Method for Electronic and Electrical Components*, also called high-potential, overpotential, voltage-breakdown, or dielectric-strength test, consists of the application of a voltage higher than rated voltage for a specific time between mutually insulated portions of a component part or between insulated portions and ground.

16.10.2.29 Insulation Resistance (Mil-Std–202F Method 302). This test, from Mil-Std–202F, *Test Method for Electronic and Electrical Components*, measures the resistance offered by the insulating members of a component part to an impressed direct voltage tending to produce a leakage current through or on the surface of these members.

16.10.3 Sufficiency of Samples. Fire investigators often misunderstand the abilities of laboratory personnel and the capabilities of their scientific laboratory equipment. These misconceptions usually result in the fire investigator's collecting a quantity of physical evidence that is too small to examine or test.

16.10.3.1 Certainly, the fire investigator will not always have the opportunity to determine the quantity of physical evidence he or she can collect. Often, the fire investigator can collect only that quantity that is discovered during his or her investigation.

16.10.3.2 Each laboratory examination or test requires a certain minimum quantity of physical evidence to facilitate proper and accurate results. The fire investigator should be familiar with these minimum requirements. The laboratory that examines or tests the physical evidence should be consulted concerning these minimum quantities.

16.10.4 Comparative Examination and Testing.

16.10.4.1 During the course of certain fire investigations, the fire investigator may wish to have appliances, electrical equipment, or other products examined to determine their compliance with recognized standards. Such standards are published by the American Society for Testing and Materials, Underwriters Laboratories Inc., and other agencies.

16.10.4.2 Another method of comparative examination and testing involves the use of an exemplar appliance or product. Utilizing an exemplar allows the testing of an undamaged example of a particular appliance or product to determine whether or not it was capable of causing the fire. The sample should be the same make and model as the product involved in the fire.

16.11 Evidence Disposition.

16.11.1 The fire investigator is often faced with disposing of evidence after an investigation has been completed. The investigator should not destroy or discard evidence unless proper authorization is received. Circumstances may require that evidence be retained for many years and ultimately may be returned to the owner.

16.11.2 Criminal cases such as arson require that the evidence be kept until the case is adjudicated. During the trial, evidence submitted — such as reports, photographs, diagrams, and items of physical evidence — will become part of the court record and will be kept by the courts. Volatile or large physical items may be returned to the investigator by the court. There may be other evidence still in the investigator's possession that was not used in the trial. Once all appeals have been exhausted, the investigator may petition the court to either destroy or distribute all of the evidence accordingly. A written record of authorization to dispose of the evidence should be kept. The criminal investigator should be mindful of potential civil cases resulting from this incident, which may require retention of the evidence beyond the criminal proceedings.

Chapter 17 Origin Determination

17.1 Introduction. This chapter recommends a procedure to follow in determining the origin of a fire. Chapter 18 further develops the investigative efforts based on the results from the origin determination. Generally, if the origin of a fire cannot be determined, the cause cannot be determined.

17.1.1 Determination of the origin of the fire frequently involves the coordination of information derived from the following:

(1) The physical marks (fire patterns) left by the fire
(2) The observations reported by persons who witnessed the fire or were aware of conditions present at the time of the fire
(3) The analysis of the physics and chemistry of fire initiation, development, and growth as an instrument to related known or hypothesized fire conditions capable of producing those conditions *(see Chapter 19)*
(4) Noting the location where electrical arcing has caused damage and the electrical circuit involved *(see Section 8.10)*

17.1.2 In some instances, a single item, such as an irrefutable article of physical evidence or a dependable eyewitness to the initiation, can be the basis for a conclusive determination of origin. In most cases, however, no single item is sufficient in itself. The investigator then should use all of the available resources in developing potential scenarios and determining which scenarios plausibly fit all of the evidence available. When an apparently plausible scenario fails to fit some item of evidence, it is critical that the investigator determine whether the scenario or the evidence is erroneous. In some cases, it will be impossible to unquestionably fix the origin of a fire. It is important that the determination of a single point of origin not be made unless the evidence is conclusive. Where a single point cannot be identified, it can still be valuable for many purposes to identify possible sources of origin. In such instances, the investigator should provide a complete list of plausible explanations for the origin with the supporting evidence for each option.

17.1.3 The various activities of origin determination often occur simultaneously with those of cause investigation and failure analysis. Likewise, recording the scene, note taking, photography, and evidence identification and collection are performed simultaneously with these efforts. Generally, the various activities of origin determination will follow a routine sequence, while the specific actions within each activity are taking place at the same time.

17.1.4 The area of origin may be determined by examining the fire pattern evidence of the fire scene. If identifiable, movement and intensity fire patterns should be traced back to an area or point of origin. Once the area of origin has been

established, the investigator should be able to understand and document the fire spread. The purpose of determining the origin of the fire is to identify the geographical location where the fire began. When the area of origin has been determined, based on the patterns or any other methodologies set forth in 17.1.1 through 17.1.3, then the specific location of the origin can be identified. The specific origin will be where the heat ignited the first fuel and is commonly referred to as the point of origin.

17.1.5 Investigators should establish a systematic procedure to follow for each type of incident. By following a familiar procedure, the investigator can concentrate on the incident at hand and need not dwell on the details of what the next step in the procedure will be. More important, the investigator may avoid inadvertently overlooking a significant facet of the investigation. By starting at the area of least damage and moving to the area of greatest damage the investigator will avoid forming conclusions about the origin and will be more likely to observe all the important evidence.

17.1.6 This chapter discusses a recommended procedure for the examination of the fire scene evidence. Basically, this procedure consists of a preliminary scene examination, development of a preliminary fire-spread scenario, an in-depth examination of the fire scene, a fire scene reconstruction, development of a final fire-spread scenario, and identification of the fire's origin.

17.1.7 Throughout this chapter, the discussion addresses the recommended technique to follow when examining fire scene evidence. This technique serves to inform the investigator but is not meant to limit the origin determination to only this procedure. All aspects of the fire event should be considered by the investigator during the investigation. Such aspects as witness statements, the investigator's expertise, and fire-fighting procedures play important roles in the determination of the fire origin. However, these aspects are addressed in other areas of this guide and in other texts on these subjects.

17.2 Fire Damage Assessment. Investigators will be making assessments of fire spread throughout the examination of the scene. These assessments include recognizing and documenting heat movement and intensity patterns and analyzing the importance and direction of each pattern found. *(See Section 15.2 through Section 15.4.)*

17.2.1 Notes. During this process, the investigator should be making detailed, written or tape-recorded notes. These notes should list all the pertinent observations, including the type, location, description, and measurements of the patterns; the material on which the patterns are displayed; and the investigator's analysis of the direction and intensity of the patterns.

17.2.2 Photography. The patterns should be photographed several different ways to effectively show their shape, size, relationship to other patterns, and the location within the fire scene. These variations should include changes in the viewing angle of the camera to document the pattern as well as different lighting techniques to highlight the texture of the pattern.

17.2.3* Heat and Flame Vector Diagrams. The use of heat and flame vector diagrams can be a very useful tool for analysis by the investigator. Vectoring is applied by constructing a diagram of the scene. The diagram should include walls, doorways and doors, windows, and any pertinent furnishings or contents. Then, through the use of arrows, the investigator notes his or her interpretations of the direction of heat or flame spread based upon the identifiable fire patterns present. The arrows can point in the direction of fire travel from the heat source, or point back toward the heat source, as long as the direction of the vectors is consistent throughout the diagram. The arrows can be labeled to show any one of several variable factors, such as temperature, duration of heating, heat flux, or intensity. An example is shown in Figure 17.2.3.

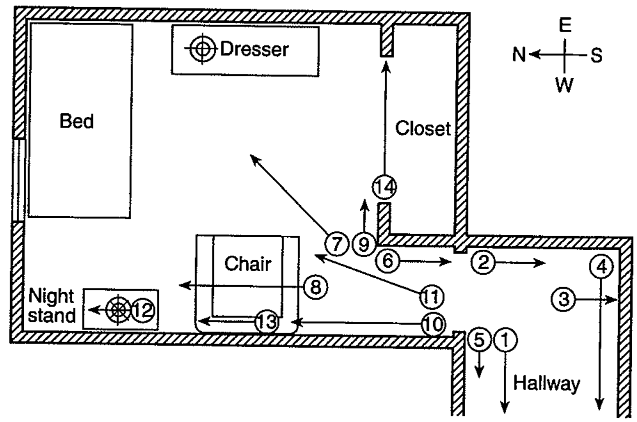

FIGURE 17.2.3 Heat and Vector Analysis Diagram Showing Vectors of the Physical Size and Direction of Heat Travel of the Fire Pattern. ***(Source: Kennedy and Shanley, "USFA Fire Burn Pattern Tests — Program for the Study of Fire Patterns.")***

17.2.3.1 Complementary vectors can be added together to show actual heat movement directions. In that case, the investigator should clearly identify which vectors represent actual fire patterns and which vectors represent heat flow derived from the investigator's interpretations of these patterns. A vector diagram can give the investigator an overall viewpoint to analyze. The diagram can also be used to identify any conflicting patterns that need to be explained.

17.2.3.2 An important point to be made regarding this discussion is the terminology *heat source* and *source of heat.* These terms are not synonymous with the origin of the fire. Instead, these terms relate to any heat source that creates an identifiable fire pattern. The heat source may or may not be generated by the initial fuel. An example of this would be a fire that spreads into a garage and ignites the flammable liquids stored there. These flammable liquids then produce a new heat source that produces fire patterns on the garage's surfaces. Therefore it is imperative that the use of heat and flame vector analysis be tempered by an accurate understanding of the progress of the fire and basic fire dynamics.

17.2.4 Depth-of-Char Survey Grid Diagrams. The investigator should record in his or her notes the results of any depth-of-char surveys that are conducted. This notation should be documented in the notes as well as on a drawn diagram. For analysis purposes, the investigator can construct a depth-of-char grid diagram. On this diagram, the char measurements are recorded on graph paper to a convenient scale. Once the depth-of-char measurements have been recorded on the diagram, lines are drawn connecting points of equal, or nearly equal, char depths. The resulting "isochars" may display identifiable lines of demarcation and intensity patterns *[see 6.5.3 and Figure 15.4.2(f)].*

17.2.5 Electrical Arc Survey.

17.2.5.1 An electrical arc survey is the identification and documentation of evidence of electrical arcs found in circuit wiring, power supply cords, or electrical appliances. The location of these arcs may provide the investigator physical evidence by identifying those circuits that were energized at the time they failed or were compromised by the developing fire. The investigator should identify structural components or membranes, which may have shielded portions of the circuit and explain why that portion of the circuit did or did not experience an arc. Alterations to the post-fire position of the electrical circuit breakers or removal of the fuses in the main electrical distribution panels or sub-panels may compromise the ability to perform this task. Structural collapse, aggressive overhaul, or prior investigations may prevent the investigator from tracing the circuit wiring back to the distribution panel.

17.2.5.2 Identifying the location of arcs may become more difficult, or impossible, if the conductor has experienced fire melting. Analysis may be required to determine the difference between melting and arcing. Finding arcs in copper conductors is more likely than on aluminum conductors due to the lower melting temperature of aluminum.

17.3 Preliminary Scene Assessment.

17.3.1 General. An initial assessment should be made of the fire scene.

17.3.1.1 This assessment should begin from the areas of least damage to the areas of greatest damage and should include an overall look at the structure, both exterior and interior, and at all pertinent areas surrounding the building. The purpose of this initial examination is to determine the scope of the investigation, such as equipment and manpower needed, to determine the safety of the fire scene, and to determine the areas that warrant further study.

17.3.1.2 Descriptions of all locations should be as precise as possible. Directions should be oriented to a compass or to a reference, such as the front of the structure. In every instance, the location and any related discussion should be stated in such a fashion that others using the description can clearly locate the area in question.

17.3.2 Surrounding Areas.

17.3.2.1 Investigators should include in their examination the areas around the structure. These areas may exhibit significant evidence or fire patterns, away from the involved structure, that enable the investigator to better define the site and the investigation. Anything of interest should be documented as to its location in reference to the structure.

17.3.2.2 Surrounding areas should be examined for evidence that may relate to the incident, such as contents from the burned structure and fire patterns. This phase of the examination can be used to canvas the neighborhood for witnesses to the fire and for persons who could provide information about the building that burned.

17.3.3 Weather. Analyze weather factors that may have influenced the fire. The surrounding area may provide evidence of the weather conditions. Wind direction may be indicated by smoke movement or by fire damage on the surrounding structures or vegetation.

17.3.4 Structural Exterior. A walk around the entire structure may reveal the extent and location of damage and may help determine the size of the scene that should be examined as well as the possibility of extension from an outside fire source. The construction and use of the structure should be noted. The construction refers to how the building was built, types of materials used, exterior surfaces, previous remodeling, and any unusual features that may have affected how the fire began and spread. A significant consideration is the degree of destruction that can occur in a structure consisting of mixed types and methods of construction. For instance, if a structure consists of two parts, one built in the early 1900s and the second built in the 1960s, the degree of destruction can vary considerably within these two areas, with all other influencing factors being equal.

17.3.4.1 The nature of occupancy refers to the current use of the building. Use is defined as the activities conducted; the manner in which such activities are undertaken; and the type, number, and condition of those individuals occupying the space. If the use of the building has changed from what it was originally built for, this change should be considered.

17.3.4.2 The fire damage on the exterior should be noted to assist in determining those areas that warrant further study. An in-depth examination of the damage is not necessary at this point in the investigation.

17.3.5 Structure Interior. On the initial assessment, investigators should examine all rooms and areas of the structure. The investigator should be observant of conditions of occupancy, including methods of storage, nature of contents, and shape of living conditions. The type of construction and surface covering should be noted. Moving from the least burned to the most burned areas, indicators of smoke and heat movement, areas of fire damage, and extent of damage in each area — severe, moderate, minor, or none — should be noted. This damage should be compared with the damage seen on the exterior. The investigator should use this opportunity to assess the soundness of the structure so that the safety of the structure can be determined. See 12.2.2 for further information regarding safety.

17.3.5.1 The primary purpose of the preliminary interior assessment is to identify the areas that require closer examination. Therefore, the investigator should be observant for possible fire origins, fire patterns, fuel loading, burning, and potential ignition sources.

17.3.5.2 During this assessment, the investigator should note any indication of post-fire site alterations. Site alterations can include debris removal or movement, content removal or movement, electrical service panel alterations to facilitate temporary lighting, and gas meter removal. Such alterations can greatly affect the investigator's interpretation of the physical evidence. If site alterations are indicated, the persons who altered the site should be questioned as to the extent of their alterations and the documentation they may have of the unaltered site.

17.3.5.3 At the conclusion of the preliminary scene assessment, the investigator should have determined the safety of the fire scene, the probable staffing and equipment requirements, and the areas around and in the structure that will require a detailed inspection. The preliminary scene assessment is an important aspect of the investigation. The investigator should take as much time in this assessment as is needed to make these determinations. Time spent in this endeavor will save much time and effort in later steps of the investigation.

17.4 Preliminary Scenario Development. The identification of areas of interest results from formulating a preliminary scenario as to how the fire spread through the structure. This preliminary scenario is developed by noting the areas of greater destruction and lesser destruction and by attempting to track the fire back to its source. Such a scenario allows the investigator to organize and plan for the work to be done. The development of the preliminary scenario is a critical point in the investigation. It is important at this stage that the investigator attempt to identify any other feasible scenarios and, through the remaining course of the investigation, keep these alternative scenarios under consideration until or at such time as conclusive evidence or rationale is developed for setting them aside.

17.4.1 One very important consideration should be kept in mind, however. The investigation should not be planned solely to prove the preliminary scenario to the detriment of maintaining an unbiased mind. The investigation is intended to identify all facts that exist and to use those facts to develop opinions based on sound fire science principles and experience. The investigative effort may cause the scenario to change many times before the final opinion is formed. These changes are why the scenario should be considered preliminary until the investigation is completed. A narrow-minded approach to this effort prevents the normal development of the scenario from preliminary to final. *(See Section 4.3.)*

17.4.2 The investigator should continue to reevaluate the areas of interest by considering the additional data accumulated as the investigation progresses. The examination and documentation of heating, ventilation, and air-conditioning (HVAC) systems; fire protection systems; cooking and other appliances; electrical distribution systems; and utilities should be included. The areas to be examined should not be limited to those that suffered fire damage. Examination of the systems that have little or no fire damage may provide assistance later in identifying the cause for the fire.

17.5 Detailed Exterior Surface Examination. Once the preliminary scene assessment is completed, the structure should be analyzed in detail. The purpose of this effort is to identify where the fire began. This analysis begins with the exterior surface examination. Even if the fire clearly originated from within the structure, the exterior analysis should be performed. Observations, photographs, and sketches can help orient the investigator to the structure, help to determine the manner in which the structure burned, and document details that may resolve issues that have not yet been raised.

17.5.1 Pre-Fire Conditions. The pre-fire conditions of the structure should be determined. Such details as state of repair, condition of foundations and chimneys, insect damage, state of repair of fire suppression systems, and so forth may prove to be significant data. Documentation of these conditions at this time may be the only opportunity to record them.

17.5.2 Utilities. The investigator should locate and document the utilities associated with the structure, including the type and rated size of the electrical service and the fuel gas type. The meter readings for the utilities that provide them should be recorded. The locations of fuel tanks and their manner of connection to the structure should be noted.

17.5.3 Doors and Windows. The condition of each door, especially those that allow access to the structure, should be documented. The investigator should note whether the door is intact or broken and whether it has been forced open. The means of securing the door, such as dead bolt, padlock, and so forth, should be documented. If the door is broken, the investigator should determine whether the door was broken before or after the fire began. In some cases this question can be answered by inspecting the splintered wood and noting whether it is burned or unburned and whether it is clean of smoke or smoke stained. Sometimes, observing whether the hidden surfaces on the door jamb or the hinges are clear of smoke can help determine the position of the door (i.e., open or closed) during the fire.

17.5.3.1 Clean surfaces indicate that the door was closed during the time smoke was present. However, stained surfaces do not always indicate the door was open. If smoke accumulates in sufficient quantity and if there is a pressure difference between the areas separated by the door, smoke can flow through cracks around a closed door to stain those hidden surfaces. The pressure differences involved can be due to the fire-produced smoke temperatures; mechanically produced air movement from ventilation, exhaust, or similar fan-driven systems; wind effects; or buoyant (stack) effects caused by the temperature differentials between the building and the exterior environment.

17.5.3.2 The condition of the windows and the glass should be documented. To ascertain what position the windows were in during the fire, the same characteristics that were discussed with the doors apply. With broken glass, the location of the pieces may provide insight as to what broke the pane. Once the fire breaches either the doors or windows, the improved ventilation affects the rate of combustion of the fire and the manner in which it spreads in the structure. The investigator should strive to learn whether the opening occurred prior to, during, or after extinguishment of the fire.

17.5.4 Explosion Evidence. Any displacement of the exterior surfaces should be documented. The distance the pieces traveled and the extent of movement of walls and roofs should be noted on a diagram of the structure. Charring or smoke staining on hidden surfaces, which became exposed by the displacement of the structural component, should be noted on the diagram also. A detailed discussion of explosions can be found in Chapter 20.

17.5.5 Fire Damage.

17.5.5.1 The fire damage on the exterior surfaces should be documented. The investigator should pay particular attention to the damage that is associated with natural and unnatural openings. Window, door, and vent openings provide natural passages for smoke and heat and can be indicators of the flow of fire and fire products. Unnatural openings include holes created by the fire and holes created during the suppression effort. Holes created by the fire indicate an area of intense burning inside the structure. Separate and distant holes created by fire can be indicative of multiple origins, concentrated fuel loads, or simply a spreading fire that developed more than one intense impact on a vulnerable point in the structure envelope.

17.5.5.2 Holes created by fire suppression activities are generally associated with forced entry attempts, ventilation of the combustion gases, or spot-fire extinguishment. Ventilation attempts can greatly affect fire movement inside the building, thereby creating fire patterns that appear abnormal. Investigators should use care in evaluating such fire damage by conferring with the fire combat personnel to learn what happened inside the structure when the ventilation took place. Such evidence can be helpful in appraising, through methods such as vectoring, the flow of fire and fire effects.

17.9.4 Inspection within the perimeter may verify the floor plan of the structure. The noncombustible contents of the structure generally will be found almost directly beneath their pre-fire location. This generally will allow the investigator to identify the bathrooms, kitchens, and utility rooms.

17.9.5 Sometimes the vertical locations of contents will assist the investigator in determining what level they had occupied within the structure. For instance, bed frames from second story bedrooms will generally end up on top of the first story contents with debris sandwiched between them.

17.9.6 Once the initial site assessment is complete, the debris should be removed carefully and the contents located, identified, and studied. One of the benefits of this type of structural destruction is that the site is rarely altered by earlier investigations or overhaul operations.

17.9.7 A purpose of the examination of the contents is to determine whether the noncombustible contents found correspond to the type and amount of contents expected in a structure of the same occupancy. Residential structures contain essential contents such as refrigerators and heating systems, and most contain other contents such as televisions and cooking appliances. These items will survive to some degree even in the most severe fires.

17.9.8 Another purpose for studying the contents is to note the differing degrees of heating effects on them. If the contents in one area of the structure exhibit melted remains while others do not, then the investigator may deduce that sustained temperatures in that area exceeded temperatures in other areas. If the metal remains of the contents are badly oxidized, such examinations may not be possible.

17.9.9 Total burn fire scenes present their own unique problems, but then so do many other fire scenes. Although the primary objective of the fire investigator is to determine the origin and cause of a fire, there are areas of interest to other involved parties that deserve to be considered. Careful examination of totally burned sites can answer questions that may arise from these other parties long after the fire scene has been cleaned up.

Chapter 18 Fire Cause Determination

18.1 General.

18.1.1 The focus of this chapter is on determining the cause of a fire or explosion incident. The determination of the cause of a fire or explosion involves consideration of the circumstances, conditions, or agencies that bring together a fuel, ignition source, and oxidizer (such as air or oxygen).

18.1.2 The determination of the cause of a fire requires the identification of those materials, circumstances, and factors that were necessary for the fire to have occurred. Those materials, circumstances, and factors include, but are not limited to, the device, appliance, or equipment involved in the ignition, the presence of a competent ignition source, the type and form of the material first ignited, and the failures (e.g., high temperature thermostat on an appliance that fails to operate), circumstances (e.g., failure to monitor a cooking pot on a stove), or human actions (e.g., failure to shut off an appliance, failure to connect electrical wiring tightly in a receptacle resulting in high resistance connection, failure to activate fire suppression equipment, or an intentional act) that allowed the materials, circumstances, and factors to come together to allow the fire to occur.

18.1.3 An individual investigator may not have responsibility for, or be required to address, all of the issues described in this section. A particular investigation may or may not require that all of these issues be addressed.

18.1.4 The cause of any particular fire may involve several circumstances and factors. For example, consider a fire that starts when a blanket is ignited by an incandescent lamp in a closet. The various factors include having a lamp hanging down too close to the shelf, putting combustibles too close to the lamp, and leaving the lamp on while not using the closet. The absence of any one of those factors would have prevented the fire. The function of the investigator is to identify those materials and circumstances that contribute to the fire. For more complex situations, techniques such as Fault Trees *(see 19.3.1)* and Failure Mode and Effects Analysis *(see 19.3.2)* are systematic methods for the analysis of systems that can help determine the cause of a fire.

18.2 Process of Elimination.

18.2.1 Any determination of fire cause should be based on evidence rather than on the absence of evidence; however, when the origin of a fire is clearly defined, it is occasionally possible to make a credible determination regarding the cause of the fire, even when there is no physical evidence of the ignition source available. This finding may be accomplished through the credible elimination of all other potential ignition sources, provided that the remaining ignition source is consistent with all known facts.

18.2.2 For example, an investigator may properly conclude that the ignition source came from an open flame, even if the device producing the open flame is not found at the scene. This conclusion may be properly reached as long as the analysis producing the conclusion follows the scientific method as discussed in Chapter 4.

18.2.3 Elimination, which actually involves the developing, testing and rejection of alternate hypotheses, becomes more difficult as the degree of destruction in the compartment of origin increases, and it is not possible in many cases. Whenever an investigator proposes the elimination of a particular system or appliance as the ignition source on the basis of appearance or visual observation, the investigator should be able to explain how the appearance or condition of that system or appliance would be different from what is observed, if that system or appliance were the ignition source for the fire.

18.2.4 There are times when visual differences do not exist; for example, when a heat-producing device or appliance ignites combustibles that are placed too close to it, the device itself may appear no different than if something else were the ignition source.

18.2.5 The "elimination of all accidental causes" to reach a conclusion that a fire was incendiary is a finding that can rarely be justified scientifically, using only physical data; however, the "elimination of all causes other than the application of an open flame" is a finding that may be justified in limited circumstances, where the area of origin is clearly defined and all other potential heat sources at the origin can be examined and credibly eliminated. It is recognized that in cases where a fire is ignited by the application of an open flame, there may be no evidence of the ignition source remaining. Other evidence, such as that listed in Section 22.3, which may not be related to combustion, may allow a determination that the fire was incendiary.

of a match were found on the burned surface of a wood end table in the area of origin, the match almost certainly would not have sufficient energy to ignite the solid wood surface. Maybe the match had been blown out and dropped there by an occupant. Was there any paper or other light-weight fuel that could have carried flame to a chair or other fuels? Remember that the initial fuel must be capable of being ignited within the limitations of the ignition source. The components in most buildings are not susceptible to ready ignition by heat sources, low energy, low temperature or short duration. For example, flooring, drywall, structural lumber, wood cabinets, and carpeting do not ignite unless they are exposed to a substantial heat source. The investigator needs to identify easily ignited items that, once ignited, could provide the heat source to damage or involve these harder-to-ignite items. *(See 5.3.1.)*

18.4.5 Unusual residues might remain from the initial fuel. Those residues could arise from thermite, magnesium, or other pyrotechnic materials.

18.4.6 Gases and vapors can be the initial fuel and can cause confusion because the point of ignition can be some distance away from where sustained fire starts in the structure or furnishings. Also, flash fire may occur with sustained burning of light density materials, such as curtains, that are located away from the initial vapor-fuel source. When ignition causes a low-order explosion, it is obvious that a gas, vapor, or dust is involved. Layered vapors of gasoline might not ignite violently so that, unless evidence of the accelerant is found, the source of ignition many feet from where the puddle burned might be difficult to associate with the fire. *(See 5.3.2, 5.3.3, and 6.19.2.)*

18.5 Ignition Sequence.

18.5.1 A fuel by itself or an ignition source by itself does not create a fire. Fire results from the combination of fuel and an ignition source. Therefore, the investigator should be cautious about deciding on a cause of a fire just because a readily ignitable fuel and potential ignition source are present. The sequence of events that allow the source of ignition and the fuel to get together establishes the cause.

18.5.2 To define the ignition sequence requires determining events and conditions that might have occurred or might have been created in the past. Furthermore, the order in which those past events occurred might have to be determined. Consider a fire in a restaurant kitchen that started when a deep-fat fryer ignited and spread fire through the kitchen. The cause is more than simply "the deep-fat fryer overheated." In this example, the investigator should seek to find an answer to the following questions as part of data gathering, and hypothesis development and hypothesis testing, in determining the fire cause as well as affixing responsibility.

(1) Was the control thermostat turned up too high?
(2) Did the control contact stick?
(3) Why did the high temperature cutoff not prevent overheating?
(4) Was there a kitchen exhaust hood present?
(5) Was there a fire suppression system present?
(6) Was a power supply shut-off provided?
(7) Were the requirements of the manufacturer met?

18.5.2.1 Those factors could make a difference between a minor incident and a large hostile fire. In each fire investigation, the various contributing factors should be investigated and included in the ultimate explanation of the ignition sequence. Furthermore, the investigator should be prepared to discuss generally the proper operation of the appliance, the safety elements built into the appliance, and the failure modes that would be necessary for the fire to have occurred.

18.5.3 The investigator should use the scientific method (see Chapter 4) as the method for data gathering, hypothesis development, and hypothesis testing regarding the consideration of potential ignition sources. This process of consideration actually involves the development and testing of alternate hypotheses. In this case, a separate hypothesis is developed considering each individual heat source in the area of origin as a potential ignition source. Systematic evaluation (hypothesis testing) is then conducted with the elimination of those hypotheses that are not supportable (or refuted) by the facts discovered through further examination. The investigator is cautioned not to eliminate a heat source merely because there is no obvious evidence for it. For example, the investigator should not eliminate the electric heater because there is no arcing in the wires or because the contacts are not stuck. There may be other methods by which the heater could have been the ignition source other than a system failure, such as combustible materials being stored too closely to it. Obviously, arson is not eliminated because a lab did not find accelerant in the evidence. Potential ignition sources should be eliminated from consideration only if there is definite evidence that they could not be the ignition source for the fire. For example, an electric heater can easily be eliminated from consideration if it was not plugged in.

18.6 Opinions. When forming opinions from hypotheses about fires or explosions, the investigator should set standards for the level of certainty in those opinions. Two levels of confidence have significance with respect to opinions:

(1) Probable. This level of certainty corresponds to being more likely true than not. At this level of certainty, the likelihood of the hypothesis being true is greater than 50 percent.
(2) Possible. At this level of certainty, the hypothesis can be demonstrated to be feasible but cannot be declared probable. If two or more hypotheses are equally likely, then the level of certainty must be "possible."

18.6.1 Use of the scientific method dictates that any hypothesis formed from an analysis of the data collected in an investigation must stand the challenge of reasonable examination, by the investigator testing his hypothesis or by the examination of others. *(See Chapter 4.)* [See *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 113 S. Ct. 2786 (1993).]

18.6.2 Ultimately, the decision as to the level of certainty in data collected in the investigation or any hypothesis drawn from an analysis of the data rests with the investigator. The final opinion is only as good as the quality of the data used in reaching that opinion. If the level of certainty of the opinion is only "possible" or "suspected," the cause should be listed as undetermined. Only when the level of certainty is considered probable can a fire cause be classified as accidental, incendiary, or natural.

Chapter 19 Analyzing the Incident for Cause and Responsibility

19.1 General.

19.1.1 The purpose of fire and explosion investigations is often much broader than just determining the cause of a fire or explosion incident. The goal of any particular fire investigation is to come to a correct conclusion about the features of a particular fire or explosion incident that resulted in death, injury, damage, or other unwanted outcome. The features can be grouped under four headings, discussed in (A) through (D).

LEXSEE

UNITED STATES OF AMERICA, Plaintiff vs. LAWRENCE R. BLACK WOLF, Jr., Defendant

CR. 99-30095

UNITED STATES DISTRICT COURT FOR THE DISTRICT OF SOUTH DAKOTA, CENTRAL DIVISION

1999 U.S. Dist. LEXIS 20736

December 6, 1999, Decided
December 7, 1999, Filed

DISPOSITION: [*1] Defendant's Motion in Limine, Docket No. 12 DENIED in part.

CASE SUMMARY:

PROCEDURAL POSTURE: Defendant moved in limine to preclude expert testimony as to origin and cause of fire defendant was alleged to have set, on the ground that the proffered testimony did not meet the standards for admissibility found in Fed. R. Evid. 702, 703, 404(b).

OVERVIEW: Defendant filed a motion in limine to exclude the trial testimony of the Government's expert, on the ground that the expert's testimony did not meet the standards for admissibility found in Fed. R. Evid. 702, 703, 404(b). The court denied the motion. The court concluded that the proffered testimony relating to the cause and origin of the fire was reliable and satisfied the first part of the Fed. R. Evid. 702/Daubert test. As for the relevancy inquiry, the second part of the test, the expert's testimony would be helpful to a jury in understanding how and where a fire was started. The proffered testimony was relevant and fulfilled the second pre-condition of admissibility. After careful review of the record in accordance with its gate-keeping obligation, the court concluded that the expert would be permitted to offer expert opinion testimony regarding the cause and origin of the fire.

OUTCOME: Defendant's motion in limine to preclude expert testimony was denied. Expert testimony proffered would be helpful to jury, reliable, and relevant, but expert was not allowed to offer testimony beyond his theories or allowed to speculate as to who caused fire and what accelerant was used.

CORE TERMS: expert testimony, reliability, reliable, scene, admissibility, gate-keeping, crawl space, scientific, probative value, limine, misleading, proffered, helpful, proffered testimony, peer review, suppress, accelerant, training, bedroom, started, arson, substantially outweighed, trier of fact, presentation, methodology, relevancy, assessing, unfair, rigor, prong

LexisNexis(R) Headnotes

Evidence > Testimony > Experts > Admissibility
Evidence > Testimony > Experts > Daubert Standard
[HN1] The admissibility of expert testimony under Fed. R. Evid. 702 -- whether based on scientific, technical or other specialized knowledge -- is governed by the Supreme Court's upholding, which requires a trial court to exercise a gate-keeping function to ensure that such testimony is both reliable and relevant.

Evidence > Testimony > Experts > Daubert Standard
[HN2] In fulfilling its gate-keeping obligation, the trial court must make certain that an expert, whether basing testimony on professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field. The Eighth Circuit Court of Appeals has endorsed a two-step process for trial courts to use in evaluating expert testimony under Fed. R. Evid. 702; first, the court must determine whether the expert's testimony is reliable, and second, whether the expert's testimony is relevant.

Evidence > Testimony > Experts > General Overview

PLAINTIFF'S EXHIBIT
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[HN3] With regard to the first prong of the test, the basic task of a trial court is to make sure that the evidentiary submission is of an acceptable evidentiary reliability. In other words, where expert testimony's factual basis, data, principles, methods, or their application are called sufficiently into question the court must determine whether the testimony has a reliable basis in the knowledge and experience of the relevant discipline. At bottom, the fundamental purpose of the reliability inquiry is to rule out proffered expert testimony that is based on subjective belief or unsupported speculation.

Evidence > Testimony > Experts > General Overview
[HN4] The law grants a trial court broad discretion in deciding how to test an expert's reliability.

Evidence > Testimony > Experts > Admissibility
Evidence > Testimony > Experts > Daubert Standard
[HN5] The trial court should look to Daubert caselaw for guidance when discerning whether expert testimony should be admitted or excluded and should apply the Daubert reliability factors if and to the extent they are reasonable measures of such testimony's reliability. In doing so, the court must customize its inquiry to fit the facts of each particular case. The Daubert factors therefore, while worthy of consideration, are not an exclusive checklist and many factors may bear on the court's Fed. R. Evid. 702 inquiry.

Evidence > Scientific Evidence > Daubert Standard
Evidence > Testimony > Experts > Admissibility
Evidence > Testimony > Experts > Daubert Standard
[HN6] The second prong of the Fed. R. Evid. 702/Daubert test requires a trial court to determine whether the evidence or testimony assists the trier of fact in understanding the evidence or determining a fact in issue. This condition precedent to admissibility is essentially a relevance consideration in which the trial court must ask whether the proposed expert testimony fits the case and will be helpful to the trier of fact in understanding the evidence or determining one or more factual issues.

Evidence > Relevance > Confusion, Prejudice & Waste of Time
Evidence > Relevance > Prior Acts, Crimes & Wrongs
Evidence > Testimony > Experts > Admissibility
[HN7] When assessing the expert testimony proffered under Fed. R. Evid. 702, a trial court must also be mindful of Fed. R. Evid. 703 and Fed. R. Evid. 404. Rule 703 provides that expert opinions based on information made known to the expert from persons and other sources are to be admitted only if the information is of a type reasonably relied upon by experts in the particular field in forming opinions or inferences upon the subject. Rule 404(b) permits the trial court to exclude relevant evidence if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury. Because expert evidence can be both powerful and quite misleading, the court, in weighing possible prejudice against the probative value under Rule 404(b), should exercise more control over experts than lay witnesses.

COUNSEL: John J. Ulrich, Assistant United States Attorney, Pierre, SD, for Plaintiff.

Anita L. Fuoss, Murdo, SD, for Defendant.

JUDGES: MARK A. MORENO, UNITED STATES MAGISTRATE JUDGE.

OPINIONBY: MARK A. MORENO

OPINION:

MEMORANDUM OPINION AND ORDER

BACKGROUND

Lawrence R. Black Wolf, Jr., ("defendant") filed a Motion in Limine n1 to exclude the trial testimony of the government's expert, Daniel Carlson, on the ground that Carlson's testimony did not meet the standards for admissibility found in Fed. R. Evid. 702, 703, 404(b) and Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 125 L. Ed. 2d 469, 113 S. Ct. 2786 (1993). Docket No. 12. The government resisted the Motion, and this Court heard testimony on the Motion and received three exhibits into evidence at a hearing held on Wednesday, November 10, 1999. For the reasons stated below, the Court denies the Motion.

n1 Defendant's Motion is styled "Motion to Suppress and Motion In Limine For Determination of Admissibility of Evidence", Docket No. 12. Defense counsel, however, admitted at the evidentiary hearing held on the Motion that the same was really one in limine and not one to suppress. H. Tr. 56.

[*2]

According to the indictment, defendant, an Indian, wilfully and maliciously set fire to and burned the residence of Edward Castaway, on or about April 9, 1999, in

the Upper Swift Bear Community near White River, South Dakota, located within the exterior boundaries of the Rosebud Indian Reservation. Docket No. 1. Ben Huber, a veteran fireman of 50 years and the Chief of the White River Fire Department for 30 years, was at the scene and helped suppress the fire. After the fire had been put out, Huber became suspicious of how it was started and contacted Carlson, who personally inspected the Castaway residence (or what was left of it) and prepared a report as to the cause and origin of the fire. It is this report, together the conclusions derived therefrom, that defendant seeks to prohibit the government from offering and/or referring to at trial.

Carlson is the South Dakota State Fire Marshal and has held this position since January, 1995. Prior to his appointment as State Fire Marshal, Carlson was the lead investigator and Chief Deputy Sheriff for the Davison County Sheriff's office for seven years, a full-time firefighter in Mitchell, South Dakota, owned a private investigation business [*3] there for ten years and in that capacity, investigated numerous fires for the Mitchell Fire Department. He has his bachelor's degree and several master's degree hours and is a member of several firefighting professional associations/organizations. Over his 25 years as a fireman, Carlson has attended numerous training seminars conducted by instructors from the National Fire Academy, including courses relating to the origin of fires and arson investigation. He and his office are charged with the training and certification of over eight thousand firefighters within the State, and himself has has been called upon to investigate fires and fire scenes in excess of one hundred times, more than half of which involved suspected arson.

Carlson personally conducted an investigation of the fire scene on April 19, 1999, some ten days after the fire occurred. n2 Upon arriving at the scene, Carlson observed the remains of a Sioux 400 home that had been almost totally destroyed by fire. He conducted a walk-around, photographed those portions of the scene he thought significant and obtained information from Huber, Mellette County Sheriff Tom Raymond and Castaway. During his investigation, he noted [*4] that there was substantial charring in the floor joists directly underneath a crawl space hole located in the northwest corner of the back bedroom of the house. Based on information provided to him by Huber and Castaway, and a comparison done of the crawl space located in the front portion of the house, Carlson opined that the fire originated in the back bedroom crawl space and was caused by the use of an accelerant. In doing so, he eliminated natural and accidental causes and concluded that the fire was incendiary.

n2 Carlson would have liked to have conducted his cause and origin investigation sooner but had not been contacted about the fire until the morning of April 19th. H.Tr. 26-27.

Defendant urges the Court to exclude this Court's testimony for several reasons. He argues:

1. That Carlson did not take any samples of the building materials or seek to have such materials analyzed in a laboratory;

2. That his theory of the cause and origin of the fire has not been subject to peer review generally [*5] accepted as accurate and reliable in fire evaluations; and

3. That by implication, he used no scientific methods or procedures to reach his opinions and conclusions and that the same are nothing more than subjective speculation.

The government, on the other hand, asserts that Carlson's extensive background, training and experience makes him qualified to testify as an expert witness as to the cause and origin of the fire.

DISCUSSION

A. Legal Framework -- Reliability and Relevance

[HN1] The admissibility of expert testimony under Fed. R. Evid. 702 -- whether based on "scientific," "technical" or "other specialized" knowledge -- is governed by the Supreme Court's upholding in Daubert, which requires a trial court to exercise a "gate-keeping" function to ensure that such testimony is both reliable and relevant. Kumho Tire Co. v. Carmichael, 526 U.S. 137, 141, 119 S. Ct. 1167, 1171, 143 L. Ed. 2d 238 (1999); Daubert, 509 U.S. at 589-92; see also, Blue Dane Simmental Corp. v. American Simmental Assoc., 178 F.3d 1035, 1040 (8th Cir. 1999); Weisgram v. Marley Co., 169 F.3d 514, 517 (8th Cir. [*6]), cert. granted in part, 120 S. Ct. 11, and dismissed in part, 120 S. Ct. 443 (1999). [HN2] In fulfilling its "gate-keeping" obligation, the trial court must "make certain that an expert, whether basing testimony on professional studies or personal experience, employs in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field." Kumho Tire, 526 U.S. at , 119 S. Ct. at 1176. In the wake of Daubert and Kumho Tire, the Eighth Circuit has endorsed a two-step process for trial courts to use in evaluating expert testimony un-

der Rule 702; first, the court must determine whether the expert's testimony is "reliable", and second, whether the expert's testimony is "relevant". See, e.g., Blue Dane Simmental Corp., 178 F.3d at 1040; Forklifts of St. Louis, Inc. v. Komatsu Forklift, USA, Inc., 178 F.3d 1030, 1035 (8th Cir. 1999); Jaurequi v. Carter Mfg. Co., 173 F.3d 1076, 1082-85 (8th Cir. 1999); see also, Kumho Tire, 526 U.S. at , 119 S. Ct. at 1171 ("[Daubert] pointed out that [expert] testimony is admissible only [*7] if it is both relevant and reliable."); id., 526 U.S. at , 119 S. Ct. at 1176 ("the objective of [the Daubert gatekeeping requirement] is to ensure the reliability and relevancy of expert testimony.").

[HN3] With regard to the first prong of the test, the basic task of a trial court is to make sure that the evidentiary submission is of an acceptable "evidentiary reliability." Daubert, 509 U.S. at 590. In other words, "where [expert] testimony's factual basis, data, principles, methods, or their application are called sufficiently into question . . . the [court] must determine whether the testimony has 'a reliable basis in the knowledge and experience of [the relevant] discipline.'" Kumho Tire, 526 U.S. at , 119 S. Ct. at 1175 [brackets in original] (quoting Daubert, 509 U.S. at 592). At bottom, the fundamental purpose of the reliability inquiry is to rule out proffered expert testimony that is based on subjective belief or unsupported speculation. Daubert, 509 U.S. at 590.

[HN4] Importantly, the law grants a trial court broad discretion in deciding how to test an expert's reliability. Kumho Tire, [*8] 526 U.S. at , 119 S. Ct. at 1174-76; Forklifts of St. Louis, 178 F.3d at 1035. [HN5] The trial court should look to Daubert for guidance when discerning whether expert testimony should be admitted or excluded and should apply the Daubert reliability factors if and to the extent they are "reasonable measures" of such testimony's reliability. Kumho, 526 U.S. at , 119 S. Ct. at 1174-76; Jaurequi, 173 F.3d at 1082-83; Pestel v. Vermeer Mfg. Co., 64 F.3d 382, 384 (8th Cir. 1995). In doing so, the court "must customize its inquiry to fit the facts of each particular case[.]" Jaurequi, 173 F.3d at 1083 (citing Daubert, 509 U.S. at 594 ("the inquiry envisioned by Rule 702 is, we emphasize, a flexible one.") (footnote omitted)); id., 509 U.S. at 591 (the gatekeeping inquiry must be "tied to the facts" of a particular "case"). The Daubert factors therefore, while worthy of consideration, are not an exclusive "checklist" and "many factors may bear on [the] court's Rule 702 inquiry." Jaurequi, 173 F.3d at 1084; see also, Kumho Tire, 526 U. [*9] S. at , 119 S. Ct. at 1175-76; Daubert, 509 U.S. at 593.

[HN6] The second prong of the Rule 702/Daubert test requires a trial court to determine whether the evidence or testimony assists the trier of fact in understanding the evidence or determining a fact in issue. Daubert, 509 U.S. at 591. This condition precedent to admissibility is essentially a relevance consideration in which the trial court must ask whether the proposed expert testimony "fits" the case and will be "helpful" to the trier of fact in understanding the evidence or determining one or more factual issues. 509 U.S. at 591-92.

[HN7] When assessing the expert testimony proffered under Rule 702, a trial court must also be mindful of Fed. R. Evid. 703 and 404. 509 U.S. at 595. Rule 703 provides that expert opinions based on information made known to the expert from persons and other sources are to be admitted only if the information is "of a type reasonably relied upon by experts in the particular field in forming opinions or inferences upon the subject." Rule 404(b) permits the trial court to exclude relevant evidence "if its probative value is substantially [*10] outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury . . . ." Because expert evidence can be both powerful and quite misleading, the court, in weighing possible prejudice against the probative value under Rule 404(b), should exercise more control over experts than lay witnesses. 509 U.S. at 595.

B. Application

In the instant case, the government seeks to offer the expert testimony of Carlson as to the cause and origin of the Castaway house fire. Specifically, the government desires to offer his opinion and investigative conclusion that the fire was started by the use of an accelerant that was applied to the entrance of a crawl space situated in the back bedroom of the residence. Notably, no attempt is being made by the government to solicit an opinion from Carlson that defendant was the one who set fire to and/or burned down the house.

This Court has considered the Daubert reliability factors:

> 1. Whether the theory/technique has been tested;
>
> 2. Whether it has been subject to peer review;
>
> 3. What the known rate of error is; and
>
> 4. Whether the theory/technique is generally accepted by the community. [*11]

509 U.S. at 592-94; Pestel, 64 F.3d at 384. These factors, while perhaps pertinent, are not particularly helpful in analyzing whether Carlson's opinions and conclusions would assist a jury in deciding this case. See Pestel, 64

F.3d at 384. He does not seek to offer testimony about an untested novel concept such as might be found in a case involving presentation of purely cutting-edge scientific testimony. Instead, he proposes to testify based on his vast fire investigation experience as to how and where the fire began. Thus, whether Carlson's proffered expert opinions have been subject to peer review, whether there is a known error rate and whether his theory or technique enjoy general acceptance within relevant scientific community are not particularly appropriate and useful considerations, especially in a case such as this one where orthodox scientific methodology is involved. See Kumho Tire, 526 U.S. at , 119 S. Ct. at 1175 (observing that the Daubert factors "may or may not be pertinent in assessing reliability, depending on the nature of the issue, the expert's particular expertise, and the subject of his [*12] testimony").

This Court is satisfied that Carlson's opinions and conclusions concerning the cause and origin of the fire are reliable enough to be admitted. Carlson has an extensive background in firefighting and fire cause and origin investigation. He carefully scrutinized the fire scene, talked to individuals who provided him with relevant information, and took photographs of the remains in support of his cause and origin theories. Although he did not sample or test any of the debris from the house, or use a portable hydrocarbon detector ("sniffer") to confirm his theories as to the fire's cause and origin, nonetheless, given the amount of rain that the fire scene had been exposed to prior to his arrival and the evidence and circumstances present, it cannot be said that Carlson acted unreasonably so as to taint the validity of his theories as to what happened. Significantly, the investigative protocol he utilized, albeit somewhat individualized in nature, was consistent with the basic methodology and procedures recommended by the National Fire Protection Association (NFPA). See defendant's Exhibit A -- NFPA 921 Guide For Fire and Explosion Investigations 1998 Edition. While [*13] Carlson may not have complied to the letter with the NFPA recommendations in conducting his cause and origin investigation, he still employed, in this Court's view, the requisite level of "intellectual rigor" that is demanded of experts in the field of fire cause and origin investigations. The Court accordingly concludes that Carlson's proffered testimony relating to the cause and origin of the fire is reliable and satisfies the first part of the Rule 702/Daubert test.

As for the relevancy inquiry, the second part of this test, there can be no doubt that Carlson's testimony will be helpful to a jury in understanding how and where the fire was started. Both of these considerations are important issues in the case and will assist the jury in determining whether the fire was caused by arson or by some other non-criminal means. The "fit" or connection between Carlson's expert testimony and the causation issues the jury must decide is obvious. This being the case, the proffered testimony is relevant and fulfills the second pre-condition of admissibility.

The proffered testimony also is based on facts and data obtained and relied upon by fire investigation experts in formulating opinions [*14] as to the cause and origin of a fire and thus satisfies the dictates of Fed. R. Evid. 703. See defendant's Exhibit A at 921-10, PP 2-4, 2-5, 921-40, P 5-3.3, 921-45-47, PP 7-1.1, -3, -3.1, -4.1, -5.19, -5.2.6, 921-79, P 12-6, 921-124, P 16-18. Additionally and perhaps more importantly, the probative value of the testimony is not substantially outweighed by the danger of unfair prejudice, confusion of the issues or misleading the jury. To the contrary, the probity of such testimony far outweighs its prejudicial effect.

Most, if not all of defendant's protestations go to the weight, not the admissibility of the proposed expert testimony. At trial, he will have an opportunity to air his criticisms and attack the credibility of Carlson's opinions and conclusions through the conventional devices of vigorous cross examination, presentation of contrary evidence and jury instructions.

After careful review of the record in accordance with its gate-keeping obligation, this Court concludes that Carlson will be permitted to offer expert opinion testimony regarding the cause and origin of the Castaway house fire. He will not, however, be allowed to offer testimony beyond his cause and origin [*15] theories or be allowed to speculate as to who caused the fire and what specific accelerant was used to start the same. See Weisgram, 169 F.3d at 518-22 (fire captain who investigated townhouse fire was qualified to offer an opinion concerning the origin of the fire but he and two other experts were not permitted to "run away" with their own unsubstantiated theories as to the precise cause of the fire).

Accordingly, based on the foregoing, and the totality of the circumstances present, it is hereby

ORDERED that defendant's Motion in Limine, Docket No. 12, shall be and is DENIED except to the extent set forth above.

Dated this 6th day of December, 1999, at Pierre, South Dakota.

BY THE COURT:

MARK A. MORENO

UNITED STATES MAGISTRATE JUDGE

*2004 U.S. Dist. LEXIS 14570, *; CCH Prod. Liab. Rep. P17,079*

Gary and Phyllis Torske, Plaintiffs, -vs- Bunn-O-Matic Corporation, Defendant.

Case No. A4-03-21

UNITED STATES DISTRICT COURT FOR THE DISTRICT OF NORTH DAKOTA, NORTHWESTERN DIVISION

2004 U.S. Dist. LEXIS 14570; CCH Prod. Liab. Rep. P17,079

July 28, 2004, Decided
July 28, 2004, Filed

PRIOR HISTORY: Torske v. Bunn-O-Matic Corp., 216 F.R.D. 475, 2003 U.S. Dist. LEXIS 10888 (D.N.D., 2003)

DISPOSITION: **[*1]** Defendant's Motion in Limine and Motion for Summary Judgment DENIED.

CASE SUMMARY

PROCEDURAL POSTURE: Plaintiff homeowners sued defendant manufacturer of coffee makers for product liability, negligence, and breach of warranties, alleging that a coffee maker caused the fire that destroyed plaintiffs' residence. Defendant filed a motion in limine to exclude the testimony of plaintiffs' expert witnesses on the grounds that their opinions were irrelevant, excludable, or otherwise inadmissible. Defendant also moved for summary judgment.

OVERVIEW: Although not an engineer, one of the experts was clearly qualified in fire investigation. Whether his expertise extended to the design and construction of coffee makers was unclear. If there was a reasonable, factual basis to support his opinion on the cause and the origin of the fire, his opinion would be admissible at trial. Defendant faulted the expert for speaking with plaintiff husband, and learning about the trouble making coffee the morning of the fire, prior to visiting the scene. Whether the husband's statements colored the expert's thinking was a matter of credibility better left to a jury. Defendant could test at trial the expert's veracity and question him about his methodology, including his adherence to fire association guidelines or lack thereof, his decision not to interview firefighters, his insurance affiliation, and his prior testimonial experience. The court refused to exclude two other experts' opinions for the same reasons. Any testimony about coffee makers other than the model owned by plaintiffs was of questionable relevance. Since the expert testimony was not excluded as defendant's motion presupposed, a grant of summary judgment was not appropriate.

OUTCOME: The court denied defendant's motion in limine and motion for summary judgment.

PLAINTIFF'S EXHIBIT
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CORE TERMS: coffee maker, scene, investigator, coffee, summary judgment, guidelines, unreliable, photograph, interview, appliance, record to support, training, expert witness, expert testimony, qualifications, expertise, methodology, credibility, adherence, destroyed, morning, adhere, assess, circumstantial evidence, proposed testimony, probative value, record support, factual basis, cause-and-origin, unsubstantiated

LexisNexis(R) Headnotes ◆ Hide Headnotes

Evidence > Testimony > Experts > Admissibility

HN1 The admissibility of expert testimony is governed by Fed. R. Evid. 702. More Like This Headnote

Evidence > Testimony > Experts > General Overview

HN2 See Fed. R. Evid. 702.

Evidence > Testimony > Experts > Admissibility

Evidence > Testimony > Experts > Qualifications

HN3 To be admitted under Fed. R. Evid. 702, an expert must be qualified and the proposed testimony must be relevant and reliable. Rule 702 is clearly one of admissibility rather than exclusion and reflects an attempt to liberalize the rules governing the admission of expert testimony. More Like This Headnote

Evidence > Testimony > Experts > Daubert Standard

Evidence > Testimony > Experts > Helpfulness

HN4 The analysis of an expert witness's proffered testimony is governed by Daubert and its progeny. In Daubert, the United States Supreme Court emphasized that a district court is to act as a "gatekeeper" when screening expert testimony for relevance and reliability. To assist district courts in this role, the Supreme Court enumerated a non-exclusive list of factors for consideration: (1) whether the theory or technique can be (and has been) tested; (2) whether the theory or technique has been subjected to peer review and publication; (3) the known rate or potential rate of error; and (4) whether the theory has been generally accepted. Daubert's progeny has provided additional factors, such as: whether the expertise was developed for litigation or naturally flowed from the expert's research; whether the proposed expert ruled out other alternative explanations; and whether the proposed expert sufficiently connected the proposed testimony with the facts of the case. More Like This Headnote

Evidence > Testimony > Experts > General Overview

HN5 A competent and qualified cause-and-origin expert in a fire case may opine on the cause of a fire, and may also rely upon reasonable inferences as to the cause of the fire, if there is a reasonable basis in the record to support such an opinion. Fire cases are unique, and theories of causation often depend on circumstantial evidence and reasonable inferences to be drawn from the evidence presented at trial. A competent and qualified cause-and-origin expert will not be allowed to "run away" and engage in speculation with unsubstantiated theories as to the cause of the fire. However, such an expert will be allowed to express opinions as to the cause and origin of the fire if there is adequate support in the trial record for such

opinions. More Like This Headnote

COUNSEL: For GARY TORSKE, PHYLLIS TORSKE, plaintiffs: Collin Paul Dobrovolny, McGee Hankla Backes & Dobrovolny PC, Minot, ND.

For BUNN-O-MATIC CORPORATION, defendant: David J. Hogue, Pringle & Herigstad, P.C., Minot, ND.

JUDGES: Daniel L. Hovland, Chief Judge, United States District Judge.

OPINION BY: Daniel L. Hovland

OPINION: ORDER DENYING DEFENDANT'S MOTION IN LIMINE AND DEFENDANT'S MOTION FOR SUMMARY JUDGMENT

This action arises out of a fire that destroyed the Plaintiffs' residence in rural Williams County, North Dakota. The plaintiffs, Gary and Phyllis Torske, contend the fire was caused by a defective coffee maker manufactured by the defendant, the Bunn-O-Matic Corporation. On April 19, 2004, Bunn-O-Matic filed a Motion in Limine and a Motion for Summary Judgment. For the reasons set forth below, the motion in limine is denied and the motion for summary judgment is denied.

I. BACKGROUND OF THE CASE

The plaintiffs, Gary and Phyllis Torske, are residents of Williams County, North Dakota. In August 1999, the Torskes purchased a coffee maker manufactured **[*2]** by the defendant, the Bunn-O-Matic Corporation (Bunn-O-Matic). Bunn-O-Matic is a Illinois corporation that does business in North Dakota.

Phyllis Torske arose on the morning of August 27, 1999, and attempted to make coffee as was her custom. The coffee maker did not work, which prompted Gary Torske to twice reset the GFCI switch on the outlet into which the coffee maker was plugged. The switch held, the coffee began brewing, and soon thereafter the Torskes were drinking their morning cup of coffee. Upon finishing their coffee, the Torskes went their separate ways to work. That afternoon a passerby, Larry Towbridge, contacted authorities to report a fire at the Torske residence. The Tioga Fire Department responded but was unable to save the Torskes' home, its contents, or adjacent property. State Farm Insurance, the Torskes' insurer, hired Harry Dodson to investigate. Dodson visited the Torskes' residence, photographed the scene, reviewed a statement given by Larry Towbridge to authorities, spoke with Gary Torske, an unnamed witness, a sheriff's deputy, and a State Farm Insurance representative. Dodson concluded the Torskes' Bunn-O-Matic coffee maker was the cause of the fire.

On **[*3]** February 21, 2003, the Torskes initiated this diversity action against Bunn-O-Matic, alleging that the coffee maker was the cause of the fire and seeking to recover under theories of product liability, negligence, and breach of express and/or implied warranties. In January 2004, and pursuant to Rule 26 (a)(1) of the Federal Rules of Civil Procedure, the Torskes disclosed to Bunn-O-Matic the following witnesses with the caveat that these witnesses were asserted experts in their field but had not been specifically retained as experts: Mark E. Goodson, W.G. Stanfield, Dave Hallman, Michael S. McGuire, Curtis Ozment, Laurel V. Waters, Jim Fairfield, Tony Cockerill, Phil Sandoval, and Lisa Jones. In addition, pursuant to Rule 26(a)(2) of the Federal Rules of Civil Procedure, the Torskes disclosed to Bunn-O-Matic the following expert witnesses: H.C. Dodson, Jeffrey L. Sellon, and John L. Schumacher. On April 19, 2004, Bunn-O-Matic filed a Motion in Limine seeking to exclude the testimony of these witnesses on the grounds their opinions are irrelevant, excludable, or otherwise inadmissible under the Federal Rules **[*4]** of Evidence. In addition, Bunn-O-Matic

filed a Motion for Summary Judgment.

II. LEGAL DISCUSSION

A. BUNN-O-MATIC'S MOTION IN LIMINE

*HN1*The admissibility of expert testimony is governed by Rule 702 of the Federal Rules of Evidence, which provides:

> *HN2*If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training or education, may testify thereto in the form of an opinion or otherwise.

Fed. R. Evid. 702. *HN3*To be admitted under Rule 702, the expert must be qualified and the proposed testimony must be relevant and reliable. Rule 702 "is clearly one of admissibility rather than exclusion" and "reflects an attempt to liberalize the rules governing the admission of expert testimony." Lauzon v. Senco Products, 270 F.3d 681, 686 (8th Cir. 2001).

*HN4*The analysis of an expert witness's proffered testimony is governed by Daubert v. Merrell Dow Pharms., 509 U.S. 579, 125 L. Ed. 2d 469, 113 S. Ct. 2786 (1993) and its **[*5]** progeny. In Daubert, the United States Supreme Court emphasized that a district court is to act as a "gatekeeper" when screening expert testimony for relevance and reliability. To assist district courts in this role, the Supreme Court enumerated a non-exclusive list of factors for consideration:

(1) whether the theory or technique can be (and has been) tested;

(2) whether the theory or technique has been subjected to peer review and publication;

(3) the known rate or potential rate of error; and

(4) whether the theory has been generally accepted.

Daubert v. Merrell Dow Pharms., 509 U.S. 579, 593-94, 125 L. Ed. 2d 469 (1993). "Daubert's progeny has provided additional factors, such as: whether the expertise was developed for litigation or naturally flowed from the expert's research; whether the proposed expert ruled out other alternative explanations; and whether the proposed expert sufficiently connected the proposed testimony with the facts of the case." Lauzon v. Senco Products, 270 F.3d 681, 687.

1) EXPERT WITNESS HARRY DODSON

As noted earlier, Harry Dodson is the fire investigator initially retained by State Farm **[*6]** Insurance to examine the remains of the Torske residence. Bunn-O-Matic takes exception to the manner in which Dodson conducted his investigation, asserting that his methodology and opinions are unreliable. In addition, Bunn-O-Matic contends Dodson should not be allowed to offer an opinion as to the coffee maker's alleged defects because he is not an expert in that area. Not surprisingly, the Torskes disagree and tout Dodson's credentials along with his previous recognition as an expert in other, unrelated court proceedings.

Bunn-O-Matic emphasizes that Dodson is not an engineer and that his experience and training as a fire scene investigator does not encompass the design, manufacture, or construction of coffee makers. Thus, according to Bunn-O-Matic, Dodson can only speculate as to the alleged defective design and construction of the coffee maker at issue. For support, Bunn-O-Matic relies primarily upon a case entitled Weisgram v. Marley, Co., 169 F.3d 514 (8th Cir. 1999).

In response, the Torskes' cite Dodson's credentials. The Torskes also note that Dodson has, by his own estimation, investigated between fifty and sixty fires where a coffee maker was the suspected **[*7]** cause of the fire. Finally, the Torskes dismiss Weisgram as factually distinguishable.

In Weisgram, the Eighth Circuit Court of Appeals held that an expert in fire investigation was free to testify on the origin of the fire, but was not qualified to offer an opinion as to whether a baseboard heater, the purported cause of the fire, had malfunctioned. The Court said the fire investigator had "run away" with his own unsubstantiated theories as to the cause of the fire "by relying on inferences that have absolutely no record support." 169 F.3d 514, 519 (8th Cir. 1999). In other words, there was no foundation nor any basis in the record to support the opinions on causation offered by the fire investigator.

In this case, there is no question that Dodson has extensive experience and training as a fire scene investigator. He is certainly qualified as an expert in fire investigations. Whether Dodson's expertise and training extends to the design, construction, and manufacturing of coffee makers is unclear at this stage. In Weisgram, the court said the expert's qualifications as a fire investigator "did not give him free rein to speculate before the jury as to the **[*8]** cause of the fire by relying on inferences that have absolutely no record support." 169 F.3d 514, 519. However, it is clear that *HN5* a competent and qualified cause-and-origin expert in a fire case may opine on the cause of the fire, and may also rely upon reasonable inferences as to the cause of the fire, if there is a reasonable basis in the record to support such an opinion. Fire cases are unique, and theories of causation often depend on circumstantial evidence and reasonable inferences to be drawn from the evidence presented at trial. It is premature at this stage for the Court to wholly exclude Dodson's opinions as to cause and origin. If there is a reasonable, factual basis in the record to support Dodson's opinion on the cause and the origin of the fire, his opinion will be admissible at trial. If not, his opinion will be excluded under Weisgram. A competent and qualified cause-and-origin expert will not be allowed to "run away" and engage in speculation with unsubstantiated theories as to the cause of the fire. However, such an expert will be allowed to express opinions as to the cause and origin of the fire if there is adequate support in the trial record for **[*9]** such opinions. The Court will next address Bunn-O-Matic's assertion that Dodson's metholodogy was suspect and that his findings were neither reliable nor trustworthy.

According to Bunn-O-Matic, Dodson acted as State Farm Insurance's hand and conducted a cursory investigation rather than as a comprehensive, independent investigation into the Torske fire. Bunn-O-Matic faults Dodson for failing to personally interview Larry Towbridge and the firemen at the scene; for neglecting to photograph all of the appliances at the scene; for moving a number of items before photographing them in their original condition; for failing to review the circuit breakers with Gary Torske; for destroying the notes taken at the scene; and for neglecting to faithfully follow the rigors of the National Fire Protection Association (NFPA) 921 Guide for Fire and Explosion Investigations. Bunn-O-Matic also chides Dodson for failing to record the names of those witnesses he did speak with and for giving an inordinate amount of weight to statements made by the Torskes and State Farm Insurance representatives.

In response, the Torskes maintain that Bunn-O-Matic's criticisms of Dodson are invalid and that Dodson's **[*10]** investigation was thorough. In addition, the Torskes note that Dodson has co-authored a book on fire investigations and has contributed to the NFPA 921 Guide for

Fire and Explosion Investigations. The Torskes also note the unique problem that a fire poses for investigators, that is, the scene is less than pristine and the evidence of causation tends to be destroyed.

Having carefully reviewed Dodson's deposition testimony, the Court cannot dismiss Dodson's methodology as unreliable. Dodson did speak with Gary Torske prior to visiting the scene and learned the Torskes had difficulty making coffee the morning of their fire. However, Dodson remains adamant that his findings were based upon his first hand observations. He stresses the fact that he spent two days at the scene sifting through the remains of the Torskes' home while recording his observations and taking photographs Whether Gary Torske's statements colored Dodson's thinking is open for debate. To accept either parties' assertion would require the Court to assess Dodson's credibility, a task better left for the jury.

The fact that Dodson did not photograph every appliance or interview all of the witnesses is a subjective criticism. **[*11]** At this point in time it is unclear why Dodson chose not to seek out and interview firemen or Larry Towbridge. However, it is equally unclear if such interviews would have been practical or would have provided Dodson with any additional insight into the investigation. With respect to the photographs or lack thereof, Bunn-O-Matic's criticisms beg the question of how many photographs should have been taken.

It seems reasonable and prudent to afford some deference to an investigator's judgment, especially when the investigator is able to view the scene in its entirety. As noted above, Dodson spent two days at the scene taking notes and examining the rubble. Although Dodson did not photograph every appliance, it is apparent from his deposition testimony that his movement was not confined to one specific area of the fire scene and his examination was not limited to a single appliance. Rather, it appears Dodson moved through the rubble, examined a number articles scattered throughout, and checked all appliances.

Further, the Court is not persuaded that the destruction of Dodson's field notes constitutes a basis for excluding Dodson's opinions or testimony at trial. Apparently, it is Dodson's **[*12]** practice to destroy his field notes after transferring them to his computer. According to Dodson, his original notes are destroyed as a precautionary measure because they may be physically contaminated by the scene and pose a threat to those who handle them. While Bunn-O-Matic may question the veracity of this explanation, it presumably has received a copy of the notes in their computer form. In any event, the Court does not view Dodson's actions as presumptively unreasonable since the substance of his field notes have been electronically preserved.

Dodson's alleged failure to adhere to NFPA guidelines is somewhat more problematic. Although the Torskes do not explicitly refute Bunn-O-Matic's assertion that Dodson did not follow all NFPA guidelines, they claim that Bunn-O-Matic's advocacy of rigid adherence to NPFA guidelines ultimately undermines its assertion regarding Dodson's conversations with Gary Torske. In addition, the Torskes have submitted a statement from Dodson wherein he (1) disputes the assertion that his investigation was lacking or otherwise conducted in a manner non-compliant with recognized protocol, (2) states that any discussion of protocol during his deposition **[*13]** tends to be superficial because he was never asked the "how and the why" of his actions, (3) alludes to his strict adherence to unspecified investigative procedures used by his company during fire investigations, (4) indicates that others may not adhere to the same procedures, and (5) suggests that the experts opinions on which Bunn-O-Matic's criticisms are based are unreliable experts.

Having carefully reviewed the parties' filings along with the transcript of Dodson's deposition, the Court concludes that the exclusion of Dodson's testimony at trial for failure to strictly follow NFPA guidelines is not warranted under the circumstances. It is not readily apparent that a failure to strictly adhere to all NFPA guidelines renders an investigation incomplete or unreliable. In addition, while these guidelines provide a legitimate criteria for evaluating an

investigation, there is nothing before the Court to suggest they are exhaustive or exclusive.

Bunn-O-Matic will be afforded an opportunity at trial to inquire about the "how and the why" of Dodson's actions. Bunn-O-Matic will have an opportunity at trial to test Dodson's veracity and credibility and to question Dodson about his methodology, **[*14]** his adherence to NFPA guidelines or lack thereof, his decision not to interview the firefighters or Larry Towbridge, his affiliation with State Farm Insurance, and his prior testimonial experience. It is ultimately for the jury to assess Dodson's credibility and to assess what weight, if any, Dodson's opinions are entitled.

2) EXPERT WITNESSES JEFFREY L. SELLON AND JOHN L. SCHUMACHER

Jeffrey Sellon is an electrical engineer who is also a certified fire and explosion expert, certified fire investigation instructor, and a certified vehicle fire investigator. Sellon conducted a fire cause analysis at the Torskes' request. In his report to the Torskes dated September 26, 2002, Sellon stated his investigation had yielded the following: (1) the probable cause of the fire was a failure in the coffee maker or its cord, (2) the specific failure of the coffee maker was not determined due to the severe damage caused by the fire, and (3) a failure of the GFCI receptacle and the associated house wiring was eliminated as the cause of the fire. Sellon's opinions were reviewed and affirmed by John L. Schumacher, a chemical engineer who has eleven years of forensic engineering experience **[*15]** and specializes in causes of fire and explosions.

Bunn-O-Matic's criticisms of Sellon and Schumacher mirror those leveled against expert witness Dodson. Bunn-O-Matic contends that neither Sellon nor Schumacher have the requisite expertise in the design, construction, and manufacture of a coffee maker to offer an opinion regarding the coffee makers alleged defects. In addition, Bunn-O-Matic contends that Sellon's and Schumacher's opinions are untrustworthy as neither were able to identify a specific problem or defect with the coffee maker and both have relied upon unreliable information provided to them by Dodson. In response, the Torskes assert that Sellon and Schumacher are qualified, that their opinions have a solid foundation, and that their conclusions are borne out by circumstantial evidence.

For the reasons discussed above as to expert witness Dodson (see pp. 5-6), the Court believes it is premature to wholly exclude such opinions as to the cause and origin of the fire. Again, if there is a reasonable and adequate factual basis in the record to support such expert opinions, by inference or otherwise, the opinions will likely be admissible. If not, opinions as to the cause **[*16]** of the fire will likely be excluded under Weisgram.

3) PURPORTED EXPERTS WITNESSES NOT RETAINED AS EXPERTS FOR THE PURPOSES OF THIS CASE

As noted above, the Torskes identified the following persons as potential witnesses: Mark E. Goodson, W.G. Stanfield, Dave Hallman, Michael S. McGuire, Curtis Ozment, Laurel V. Waters, Jim Fairfield, Tony Cockerill, Phil Sandoval, and Lisa Jones. Apparently Hallman, McGuire, Ozment, and Waters have reported on and testified in other, unrelated court proceedings about problems with Bunn-O-Matic coffee makers. Fairfield, Cockerill, Sandoval, and Jones are employees of State Farm Insurance. However, Bunn-O-Matic has yet to receive any information concerning their qualifications or opinions in this case.

Bunn-O-Matic contends that any opinion expressed by the above-named witnesses would be unreliable and irrelevant. Specifically, Bunn-O-Matic contends these individuals have not independently investigated or have independent knowledge of this case. In addition, Bunn-O-Matic contends the reports of these individuals, which are related to the litigation of other claims against Bunn-O-Matic, do not concern the model of Bunn-O-Matic coffee **[*17]** maker at issue in this lawsuit. Hence, any probative value of their testimony would be

outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury. See Fed. R. Evid. 403.

Notably, the Torskes have not addressed these concerns in their response in opposition to Bunn-O-Matic's motion. The Torskes' failure to address these concerns could be construed as an admission that Bunn-O-Matic's motion as it pertains to Goodson, Stanfield, Hallman, McGuire, Ozment, Waters, Fairfield, Cockerill, Sandoval, and Jones is well-taken. In any event, the Court agrees that any testimony concerning problems with Bunn-O-Matic coffee makers other than the model owned by the Torskes is of questionable relevance and the probative value of such testimony may be substantially outweighed by the danger of unfair prejudice. With that, the Court simply notes that discovery is ongoing and that Bunn-O-Matic is still in the process of collecting information concerning the qualifications and opinions of these witnesses.

B. MOTION FOR SUMMARY JUDGMENT

The crux of Bunn-O-Matic's motion for summary judgment is that the Torskes cannot prevail **[*18]** without the inadmissible testimony of their expert witnesses. Thus, their motion presupposes that the Court will exclude all of the testimony of the expert witness retained by the Torskes. However, such is not the case. Given the disputed material facts in this case, a grant of summary judgment would be inappropriate.

III. CONCLUSION

Bunn-O-Matic's Motion in Limine (Docket No. 26) is **DENIED.** Bunn-O-Matic's Motion for Summary Judgment (Docket No. 26) is **DENIED.**

IT IS SO ORDERED.

Dated this 28 day of July, 2004.

Daniel L. Hovland, Chief Judge

United States District Court

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Briefs and Other Related Documents

Erie Ins. Exchange ex rel. McCracken v. Applica Consumer Products, Inc.M.D.Pa.,2005.

United States District Court,M.D. Pennsylvania.

ERIE INSURANCE EXCHANGE, as Subrogee of Donald McCracken Plaintiff

v.

APPLICA CONSUMER PRODUCTS, INC., Formerly Known as Windmere Corp., Defendant

No. 3:CV-02-1040.

May 17, 2005.

Edward S. Neyhart, Byrne & Neyhart, Scranton, PA, for Plaintiff.
Rochelle M. Fedullo, Wilson, Elser, Moskowitz, Edelman & Dicker, Philadelphia, PA, for Defendant.

MEMORANDUM

VANASKIE, Chief J.

***1** Defendant Applica Consumer Products, Inc. ("Applica") has moved for summary judgment based upon Plaintiff's failure to preserve the fire scene for inspection and failure to preserve relevant evidence from the fire scene. Plaintiff Erie Insurance Exchange ("Erie"), as a suborgee of Donald McCracken, the former owner of the property where the fire occurred, asserts that the fire was caused by a malfunction in a coffee maker that was manufactured and placed into the stream of commerce by Applica under the trade name of "Black & Decker." In its motion Applica claims that Erie's failure to timely notify it of a possible subrogation claim prevented Applica's representatives from conducting their own investigation of the fire scene, and Erie's failure to preserve an electric range located in the kitchen of the McCracken home prevented it from investigating other potential causes of the fire.

Applica claims that Erie's failure has impaired its ability to put forth an adequate defense and, therefore, judgment should be entered in its favor. Applica has also filed a companion motion requesting the Court to exclude the testimony of Erie's electrical engineering expert, Randolph Marshall, on the basis that it lacks reliability. Applica maintains that judgment must be entered in its favor if Mr. Marshall's testimony is excluded. For the reasons set forth below, the Motion for Summary Judgment and the Motion to Preclude the Testimony of Randolph Marshall will be denied.

I. BACKGROUND

On November 14, 2000, a fire occurred at 86 Leisure Lands, East Stroudsburg, Pennsylvania, the home of Donald McCracken ("McCracken"). The fire caused extensive damage to Mr. McCracken's home. He incurred repair costs of $85,808.78, and personal property damage of $74,400. (*Id.*) The McCracken home was insured under a policy issued by Erie. Upon receiving notice of the fire by McCracken, Erie immediately retained Michael J. Hartley ("Hartley") of HSH Investigations, to investigate the cause and origin of the fire. Hartley conducted his investigation the day following the fire and determined that the cause of the fire was a coffee maker that was located on the kitchen countertop in the McCracken home. (Hartley's report of 11/16/00 at 3.) The coffee maker was a Black & Decker, Versa Brew Series DCM 1250. During his investigation of the fire scene, Hartley was accompanied by a Pennsylvania State Police Fire Marshal, who concurred with his determination. (*Id.*) At the conclusion of his investigation, Hartley removed the Black & Decker coffee maker, a toaster oven, a waffle iron, and an electrical outlet from the scene of the fire as possible ignition sources. Hartley did not remove an electric range that was located in the kitchen because he had ruled it out as a possible source of the fire. Photographs as well as a videotape were taken of the scene of the fire. Erie also retained the expert services of Randolph Marshall ("Marshall") of Dawson Engineering, Inc. Marshall is an electrical engineer who was hired to investigate the cause of the fire and to perform tests on the coffee maker to determine whether it was defective. Erie insisted that the coffee maker be fully examined by Marshall prior to notifying any potential subrogation targets. Marshall's examination of the coffee maker was completed approximately four (4) months after the fire occurred. (Id. at 2) Upon receiv-

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ing Marshall's report, notice was given to Applica of a possible subrogation claim. At that time, the fire scene was no longer available for Applica to conduct its own inspection.

***2** Marshall prepared three reports pertaining to the cause of the fire. In each report, he expressed his professional opinion that the fire at the McCracken residence was caused by a malfunction of the Black & Decker coffee maker. (E.g., Marshall's Engineering Report of 1/7/04 at 6.) Applica had the opportunity to review Marshall's reports as well as review Erie's investigation file, photographs, and videotape of the fire scene. Applica also hired its own electrical engineering expert, Lawrence Sacco ("Sacco"), to evaluate and examine the coffee maker. In his report, Sacco opined that the coffee maker was not the cause or origin of the fire. (Sacco's Engineering Report of 12/23/03 at 4.) He believed that the coffee maker was exposed to an external fire attacking it from the left, the exact location of McCracken's electric range, and as such, he felt that the electric range could not be eliminated as the source of the fire. (*Id.* at 2, 4.) Applica claims that Erie's conduct in failing to preserve the fire scene so that Applica could perform its own investigation, and failure to preserve the electric range in order that appropriate tests could be performed on it to determine if it was the source of the fire, has prejudiced it in presenting a complete defense.

II. THE SUMMARY JUDGMENT MOTION

Summary judgment should be granted when "the pleadings, depositions, answers to interrogatories, and admissions on file, together with the affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to a judgment as a matter of law." Fed. R. Civ. P. 56(c). A fact is "material" if proof of its existence or nonexistence might affect the outcome of the suit under the applicable law. *Anderson v. Liberty Lobby, Inc.,* 477 U.S. 242, 248, 106 S.Ct. 2505, 91 L.Ed.2d 202 (1986). An issue is genuine "if the evidence is such that a reasonable jury could return a verdict for the nonmoving party." *Id.*

All doubts as to the existence of a genuine issue of material fact must be resolved against the moving party, and the entire record must be examined in the light most favorable to the nonmoving party. *Cont'l Ins. Co. v. Bodie,* 682 F.2d 436, 438 (3d Cir.1982). The moving party has the burden of showing the absence of a genuine issue of material fact, but the nonmoving party must present affirmative evidence from which a jury might return a verdict in the nonmoving party's favor. *Anderson,* 477 U.S. at 256-57. Merely conclusory allegations taken from the pleadings are insufficient to withstand a motion for summary judgment. *Schoch v. First Fid. Bancorporation,* 912 F.2d 654, 657 (3d Cir.1990). Summary judgment is to be entered "after adequate time for discovery and upon motion, against a party who fails to make a showing sufficient to establish the existence of an element essential to that party's case, and on which that party will bear the burden of proof at trial ." *Celotex Corp. v. Catrett,* 477 U.S. 317, 322, 106 S.Ct. 2548, 91 L.Ed.2d 265 (1986).

***3** The basis of Applica's motion for summary judgment is that Erie's failure to preserve relevant evidence from the scene of the fire and provide Applica with an opportunity to conduct its own inspection of McCracken's kitchen constitutes a spoliation of evidence, which should result in a dismissal of Plaintiff's claims. Applica's motion for summary judgment is a request for the ultimate sanction of dismissal for Erie's alleged spoliation of evidence. *See Donohoe v. American Isuzu Motors, Inc.,* 155 F.R.D. 515, 519 (M.D.Pa.1994). There is no rigid rule mandating a particular sanction upon a finding of improper destruction or loss of evidence. *See Id.*[FN1] It is a discretionary decision by the district court and this discretion should be exercised with a view toward choosing the "least onerous sanction corresponding to the willfulness of the destructive act and the prejudice suffered by the victim." *Schmid v. Milwaukee Elec. Tool Corp.,* 13 F.3d 76, 79 (3d Cir.1994) "A sanction that has the 'drastic' result of judgment being entered against the party who has lost or destroyed evidence must be regarded as a 'last resort', to be imposed only 'if no alternative remedy by way of a lesser, but equally efficient sanction is available." ' *Baliotis v. McNeil,* 870 F.Supp. 1285, 1289 (M.D.Pa.1994) (citing *Capellupo v. FMC Corp.,* 126

F.R.D. 545, 552 (D.Minn.1989)).

FN1. Sanctions that may be appropriate for the destruction of evidence include; (1) outright dismissal of claims; (2) exclusion of countervailing evidence; or (3) a jury instruction on the spoliation inference, which permits the jury to assume that destroyed evidence would have been unfavorable to the position of the offending party. *Howell v. Maytag*, 168 F.R.D. 502, 505 (M.D.Pa.1996) (citing *Schmid v. Milwaukee Elec. Tool Corp.*, 13 F.3d 76, 78 (3d Cir.1994)).

The authority to impose sanctions for the destruction of relevant evidence is recognized under state products liability law, *e.g.*, *Lee v. Boyle-Midway Household Products, Inc.*, 792 F.Supp. 1001, 1005 (W.D.Pa.1992), and the inherent power of district courts to utilize sanctions in order to "manage their own affairs so as to achieve the orderly and expeditious disposition of cases." *Chambers v. NASCO, Inc.*, 501 U.S. 32, 43, 111 S.Ct. 2123, 115 L.Ed.2d 27 (1991). As explained in *Baliotis,* "sanctions for loss of evidence is part of a district court's inherent powers ... to make discovery and evidentiary rulings conducive to the conduct of a fair and orderly trial." *Baliotis*, 870 F.Supp. at 1289.

The Third Circuit established the analytical framework for examining spoliation claims in *Schmid v. Milwaukee Elec. Tool Corp.* ., 13 F.3d 76, 79 (3d Cir.1994). In *Schmid,* the Court stated that when considering the imposition of a sanction against a party for spoliation of the evidence, three factors must be considered:

(1) the degree of fault of the party who altered or destroyed the evidence;

(2) the degree of prejudice suffered by the opposing party; and

(3) whether there is a lesser sanction [compared to the complete exclusion of evidence] that will avoid substantial unfairness to the opposing party and, where the offending party is seriously at fault, will serve to deter such conduct by others in the future.

Id.; Schroeder v. Commw. Dep't of Transp., 551 Pa. 243, 710 A.2d 23, 26-27 (Pa.1998) (the Pennsylvania Supreme Court expressly adopted the three-prong test set forth in *Schmid*). "In determining the applicability of the spoliation doctrine, a court cannot focus entirely on only one prong of the test, but must balance the facts of the case involved as to each prong." *Tenaglia v. Proctor & Gamble Inc.*, 737 A.2d 306, 308 (Pa.Super.Ct.1999).

A. Fault

***4** Applying the first prong of the *Schmid* test to Erie's actions, it appears that Erie, either through inadvertence or neglect, bears a large degree of fault for the loss of relevant evidence. The electric range that was located in McCracken's kitchen at the time of the fire was inspected by Erie's investigator and ruled out as a possible source of ignition or as a cause of the fire. The mere fact that Hartley had to rule out the electric range as a possible source of the fire makes it apparent that the appliance was important to his investigation. Yet, Erie specifically chose not to preserve the electric range as evidence even though it did preserve a toaster oven, a waffle iron, and an electric outlet. It is also apparent that one of the reasons why Erie conducted its cause and origin investigation was to determine if a subrogation claim existed.

"A litigant is under a duty to preserve evidence which it knows or reasonably should know is relevant to the action." *Baliotis*, 870 F.Supp. at 1290. This duty arises as soon as a potential claim is identified. Erie knew as early as November 16, 2000, less than 48 hours after the fire occurred, that the Black & Decker coffer maker was a potential cause of the fire, thereby making Black & Decker a potential target for subrogation.FN2 Despite this knowledge, Erie waited almost four months before contacting Black & Decker and by that time the site of the fire was no longer available for inspection. Erie claims that it had not decided to pursue a subrogation claim until approximately four months after the fire when it received the initial expert engineering report of Marshall.FN3

FN2. "[T]he knowledge of a potential subrogation claim is deemed sufficient to impose a duty to preserve evidence." *Id.*

FN3. Erie required that the coffee maker be x-rayed by Dawson Engineering in order to determine whether a defect existed in the machine prior to notifying Black & Decker of a potential subrogation claim. Erie attributes the delay in notification to Dawson Engineering because it did not complete the testing on the coffee maker until February 28, 2001. After receiving the testing results from Dawson Engineering, Erie placed Black & Decker on notice of a potential subrogation claim on March 6, 2001.

It is apparent that Erie was aware of a potential subrogation claim immediately following the fire after receiving the cause and origin report of Hartley, which concluded that the Black & Decker coffee maker was a potential cause of the fire. At that point a duty was imposed upon Erie to preserve the relevant evidence for inspection. Accordingly, Erie owed a duty to preserve evidence relevant to the origin and cause of the fire, including the electric range.

"The scope of the duty to preserve evidence is not boundless. At a minimum, however, an opportunity for inspection should be afforded to a potentially responsible party before relevant evidence is destroyed." *Baliotis,* 870 F.Supp. at 1290-91. Thus, Erie should have provided Applica with the opportunity to inspect the electric range.

Erie's motive for failure to preserve the electric range is relevant in determining what sanctions, if any, should be imposed. *Schmid* makes it clear that "the degree of fault" is the issue. The evidence as presented does not support a determination that Erie acted in bad faith. There was no evidence presented that Erie sought to destroy the fire scene or the electric range in order to prevent Applica from performing its investigation, or to divert liability away from its insured, McCracken.

B. Prejudice

***5** Having established that Erie breached its duty to preserve relevant evidence from the fire, this Court must now determine what prejudice, if any, resulted to Applica from this breach. Under the second prong of the *Schmid* analysis a manufacturer of a product that is allegedly responsible for causing a fire is prejudiced if it cannot have its own cause and origin expert inspect the fire scene for other potential causes. *Schmid,* 13 F.3d at 80 ("defendant will want as much evidence as possible [that is] relevant to the issue of causation"). However, the Black & Decker coffee maker, which Erie believes to be the cause of the fire, as well as the waffle iron, toaster oven, and the electrical outlet were preserved. Applica has had the ability to defend its product by having its expert examine the coffee maker to refute Erie's assertion that it was the cause of the fire. Plaintiff's expert, Sacco, has examined the coffee maker as well as the other appliances and has provided his opinion that the coffee maker was not the cause of the fire and that it was not defective. Furthermore, Applica has not presented any affidavits in this case that it is unable to present expert witness evidence on the cause and origin of the fire because of the inability to inspect the fire scene or the electric range. In fact, Sacco has testified that the information and evidence provided to him, which included photographs of the McCracken kitchen, videotape of the McCracken residence, Hartley's cause and origin report, and Marshall's reports were sufficient to allow him to formulate his expert opinion. Accordingly, a defense of this action has not been rendered impossible by Erie's failure to allow Applica to investigate the fire scene or its failure to preserve the electric range.

Applica's defense, however has been hampered by the destruction of the electric range. As pointed out by Applica, Erie is proceeding on a product malfunction theory. Under this approach, a plaintiff must present, *inter alia,* evidence eliminating other reasonable secondary causes for the fire. *See e.g., Walters ex rel. Walters v. General Motors Corp.,* 209 F.Supp.2d 481, 486-87 (W.D.Pa.2002). Here, Erie has presented evidence from its cause and origin expert eliminating the electric range as an ignition source, but Applica has been deprived of the means to test this assertion. Thus, Erie has prejudiced the defense of this action by failing to preserve the electric range.

The Third Circuit has indicated that "in the absence of bad faith by the breaching party and where the res-

ulting prejudice is not severe, a sanction of witness preclusion or entry of judgment is unwarranted." Schmid, 13 F.3d at 81.FN4 The Third Circuit specifically rejected a blanket preclusion rule based on the proposition that an expert witness "has an affirmative duty not to conduct an investigation without affording all potential defendants an opportunity to have an expert present." *Id.* In *Baliotis,* this Court determined that this rule applies to a fire scene. It would be impractical to require an insurance company to maintain the scene of a fire until all potential defendants are notified and afforded the opportunity to conduct independent inspections. To do so would create a safety hazard, and be wasteful and inefficient.

FN4. Dismissal of a complaint or preclusion of evidence regarding an allegedly defective product is an extreme sanction reserved only for those instances where an entire product or the allegedly defective portion of a product is lost, spoiled or destroyed. *See Mensch v. BIC Corp.,* No. Civ.A. 90-6002, 1992 WL 236965 at *2 (E.D.Pa. Sept.17, 1992).

***6** This Court in *Baliotis* determined that a lesser sanction of a "spoliation inference" was warranted under facts similar to the facts of this case. An instruction to a jury that it may consider that the lost evidence would be unfavorable to Erie is consistent with the evidentiary rationale underlying the spoliation inference. As explained in *Baliotis,* "permitting the jury to draw such an inference furthers the prophylactic and punitive purposes of the 'spoliation inference." ' *Baliotis,* 870 F.Supp. at 1292. Knowledge that sanctions may be imposed for loss of relevant evidence attending destruction of a fire scene and a possible cause of the fire, resulting in prejudice to subrogation targets, may induce insurers or property owners to provide notice to those targets and an opportunity to inspect. Accordingly, this Court will impose a sanction of a "spoliation inference" instruction to the jury at the time of trial.

III. THE ADMISSIBILITY OF MARSHALL'S TESTIMONY

Applica has filed a motion to exclude the testimony of Randolph Marshall, Erie's electrical engineering expert. Applica asserts that Marshall's conclusion lacks indicia of reliability because of the purportedly improper methodology he used in arriving at his opinions.

The admissibility of expert testimony in federal court is governed by Federal Rule of Evidence 702, which provides:

If scientific, technical or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in form of opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.

The Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals, Inc.,* 509 U.S. 579, 589, 113 S.Ct. 2786, 125 L.Ed.2d 469 (1993), held that Rule 702 imposes a special obligation on the trial judge to "ensure that any and all scientific testimony or evidence admitted is not only relevant, but reliable." The purpose of this gatekeeping role is to establish a standard of evidentiary reliability. *Id.* at 590; *Kannankeril v. Terminix Int'l Inc.,* 128 F.3d 802, 806 (3d Cir.1997).

In assessing whether the proffered scientific expert testimony is reliable, the Third Circuit has explained that the trial court should admit expert testimony "if there are 'good grounds' for the expert's conclusions," notwithstanding "the judge's belief that there are better grounds for some alternative conclusion." *Heller v. Shaw Industries, Inc.,* 167 F.3d 146, 152-53 (3d Cir.1999). "Novel" conclusions should not be excluded where the methodology and its application are reliable. *Id.* at 153. "[A]n expert opinion must be based on reliable methodology and must reliably flow from that methodology and the facts at issue-but it need not be so persuasive as to meet the party's burden of proof or even necessarily its burden of production." *Id.* at 152. Furthermore, the Supreme Court in *Daubert* emphasized that the Rule 702 inquiry was a "flexible one." *Daubert,* 509 U.S. at 594.

***7** In order to determine whether to admit the expert testimony of Marshall the Court must begin by reviewing the methodology used by Marshall in formulating his opinions. Marshall's evaluation included:

1. Exposure of a small sample of the plastic housing from the exemplar coffee maker to an open flame
2. Evaluating x-rays of the remains of the coffee maker
3. Examining the burn pattern on the coffee maker
4. Examining the damaged power cord connected to the coffee maker and an evaluation of the internal wiring of the coffee maker
5. Reviewing the videotape and photographs from the scene of the fire and a review of Hartley's cause and origin report.

The x-rays of the coffee maker revealed that the shroud of the capacitor was detached and propelled five inches away into the plastic housing, and metal splatter was found in the area of the capacitor. The only explanation, according to Marshall, for both the projection of the shroud and the splattering of metal is an explosion due to internal electrical energy. (Marshall's Engineering Report of 1/7/04 at 4.) Marshall also explains that the burn patterns on the remains of the coffee maker were consistent with an internal fire, and in addition, the damage to the circuit board could not have occurred unless the fire developed internally because the circuit board is shielded behind a plastic housing, made of heat resilient materials. (*Id.* at 5.) Thus, Marshall was able to rule out the electric range as a source of the fire since he determined that the fire was ignited internally in the coffee maker.

Applica's argument attacking Marshall's opinion is based on his failure to perform further testing to determine whether the internal components in the location of the coffee maker where Marshall claims the fire originated were capable of generating sufficient heat to ignite the fire. Applica asserts that it is this failure to perform additional testing that renders Marshall's testimony unreliable and, therefore, inadmissible.FN5

FN5. Unlike the electrical engineer whose testimony was excluded in *Pappas v. Sony Electronics, Inc.,* 136 F.Supp.2d 413 (W.D.Pa.2000), Marshall did inspect the power cord for the suspect appliance, finding that this "very important evidence needed to determine whether the [appliance] was energized at the time of the fire," *id.* at 419 n. 9, indicated that the coffee maker had been energized. Also unlike *Pappas,* Defendant in this case has failed to produce affidavits of an expert asserting that Marshall's methodology of "determining cause based on the physical evidence ran afoul of those techniques generally accepted by fire investigators." *Id.* at 423. Finally, unlike *Pappas,* other experts who examined the device in question concluded that the coffee maker was the likely origin of the fire.

Marshall's opinion is not rendered unreliable and inadmissible simply because he failed to determine the exact component of the coffee maker that caused the ignition of the internal fire. He based his conclusions on observations from x-rays and detailed examinations of the damaged product. These observations afford "good grounds" for a person with requisite expertise in electrical devices to base an opinion that an electrical source inside an appliance caused the fire. Marshall has articulated explanations premised upon electrical engineering principles that rule out a flame source external to the coffee maker. Specifically, examination of the burn patterns on the remains of the coffee maker and the results of the x-rays allowed Marshall to rule out the range as a source of ignition and conclude that an electrical malfunction inside the coffee maker triggered the fire. He pinpointed the origin of the fire to a two-inch square area housing electrical components. It is not for this Court to determine whether the opinion offered by Marshall is correct or incorrect. "The analysis of the conclusions themselves is for the trier of fact when the expert is subject to cross-examination." *In re: TMI Litigation,* 193 F.3d 613, 665 (3d Cir.1999). "The admissibility inquiry thus focuses on the principles and methodology, not the conclusions generated by the principles and methodology." *Id.* "The goal is reliability not certainty." *Id.* Despite its focus on reliability, the Court "must examine the expert's conclusions in order to determine whether they could reliably follow

from the facts known to the expert and methodology used." Heller, 167 F.3d at 153.

***8** This Court does not find that there is a significant gap between the information used by Marshall and the opinion he has proffered. His conclusions logically follow from the results of the information available to him. The fact that further testing could have been conducted by Marshall in forming his opinion is not determinative of the reliability of his testimony. The test for "admitting his expert testimony is not a question of whether his methods were perfect or whether a possibility exists that [he] might have done a better job." *Eclipse Electronics v. Chubb Corp.*, 176 F.Supp.2d 406, 412 (3d Cir.2001). Erie has presented sufficient evidence to establish the reliability of Marshall's testimony in accordance with the principles set forth in *Daubert* and Rule 702. His failure to conduct voltage or temperature testing may serve to undermine his opinions, but it does not render them inadmissible. Accordingly, Marshall's testimony will not be excluded.

IV. CONCLUSION

For the reasons set forth above, and after consideration of the degree of prejudice suffered by the Defendant, this Court concludes that "an adverse inference instruction" is appropriate as the least onerous sanction, which corresponds to the harm that resulted from Plaintiff's breach of the duty to preserve evidence. Accordingly, Defendant's motion for summary judgment will be denied. Because Randolph Marshall articulated "good grounds" for his conclusions, the motion to exclude his testimony will also be denied. An appropriate Order follows.

ORDER

NOW, THIS 16th DAY OF MAY, 2005, for the reasons set forth in the foregoing Memorandum, IT IS HEREBY ORDERED THAT:

1. Defendant's "Motion for Summary Judgment" (Dkt. Entry 43) is DENIED.

2. At the time of trial, the trier-of-fact will be permitted to draw an inference adverse to the position asserted by Plaintiff, that inference being that the evidence lost as a result of Plaintiff's failure to preserve the fire scene and electric range for inspection by Defendant would have been unfavorable to the position asserted by Plaintiff.

3. Defendant's "Motion to Exclude the Testimony of Randolph Marshall" (Dkt. Entry 44) is DENIED.

4. A telephonic scheduling conference will be held on June 3, 2005, at 11:00 a.m. Counsel for the plaintiff shall be responsible for placing the call to 570-207-5720 and all parties shall be ready to proceed before the undersigned is contacted.

M.D.Pa.,2005.
Erie Ins. Exchange ex rel. McCracken v. Applica Consumer Products, Inc.
Not Reported in F.Supp.2d, 2005 WL 1165562 (M.D.Pa.), 67 Fed. R. Evid. Serv. 313

Briefs and Other Related Documents (Back to top)

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